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Reducing the Solubility of Sericin

Hard and Soft Silks—Nature of the Boil-off Action—Preliminary Tests with Formaldehyde—Influence of the Soaking Period

By FRED. GROVE-PALMER, A.I.C.

ONE of the numerous methods of classifying the different sorts of silk is to divide them into two qualities, namely "hard"and "soft." This nomenclature is applied as the sericin or silk-gum is dissolved readily or with a certain amount of difficulty in the "boiling-off" or "de-gumming" process; in addition, the quantity of sericin present varies, being greater in "soft" silks than in "hard" ones. The best example of a "hard" silk is that spoken of in the trade as "China failure" in which the sericin content ranges around 17.8%, compared with Kashmir silk, a "soft" variety in which there is 28 to 29% of sericin.

The industry of silk cultivation is one that is aided and fostered by the Government of Kashmir, in which country the highly educated rulers have been mindful of the rapidly increasing value of silk in the markets of the world and have with commendable wisdom seized upon this additional source of revenue and means of finding employment for the large number of people who inhabit that delightful land in the North of India.

The most highly skilled sericulturists and scientists of international repute have been engaged in giving instruction to that section of the three and a half million people of Kashmir who wish to engage in the work, and so successful has been their teaching that ever-increasing quantities of silk are being shipped to European and other ports where it finds a ready sale. It is used in practically all classes of materials except perhaps the finest, for as yet the Kashmiris have not been able to reach that state of excellence of product that is found in the great Japanese filatures. So much of the success of turning out first quality silk yarn depends upon the skill of the operative, apart from the excellence of the machinery used, and though there is very fine machinery in Kashmir, there has not yet elapsed sufficient time for the workers to have acquired that dexterity which becomes second nature as time goes on. It is generally admitted that the daughters of reelers can do better work than other girls with equally sound training. Because of this, Kashmir silk cannot compete with the finest steam filature silk from the older silk producing countries, but at the same time the silk is good and can be used for a large variety of purposes; the quantity obtainable is growing year by year, though it is still lumped in with "Other Countries" in the statistics of output. All that, however, will soon alter itself; but there remains the fact that it is one of the "soft" silks, and as such has several features that cause it to differ in some degree from the remainder of those silks which are classified as "Mulberry silks"; even though it is the ordinary *Bombyx mori*, and the seed is bought in France or Italy each year as required. Such differences as there are must therefore arise from the difference of climate and details of treatment.

Nature of the Boil-off Action

The sericin of Kashmir silk may be readily taken away, which is a very useful thing from some points of view; but there are times when it may be better to have the gum rather less soluble, in cases such as when the warp is a "hard silk" and the weft a soft one, or when "souple" silk is wanted for any particular purpose, as, for instance, in the production of black "Gros de Londres" and other similar fabrics.

To understand fully what occurs when silk is boiled-off, it is necessary to glance briefly at the difference in constitution of the two substances of which "raw" silk is composed. Fibroin, which is the main bulk of the silk body and the part with which the wearer is brought into contact, has the following chemical formula: $C_{15}H_{23}N_5O_6$. This substance is made in the body of the worm and passes along two canals out by the spinnerets at its mouth where it is coated with the gum we call sericin; this has the following formula: $C_{15}H_{25}N_5O_8$. A glance at the former figures will show that sericin is practically the same as fibroin with the addition of some oxygen and water. There have been a large number of theories advanced from time to time on the subject of the formation of the silk thread or "bave" and the latest

of these, the one which seems to be receiving the most consideration from students of the matter today, is that the two fibrillae or "brins" of fibroin that are spun by the worm are coated with a cementing layer of fibroin that are spun by the worm are coated with a cementing layer of fibroin which is more liquid in constitution than the rest in order that the two "brins" may be stuck fast together, forming a single fiber. As this liquid fibroin comes into contact with the air, being in a different condition from the main supply, it takes up oxygen and water while solidifying and thus becomes chemically altered. It is therefore called by another name to distinguish it from the bulk of the silk from which its much greater solubility enables it to be removed with comparative ease.

As mentioned earlier there is about 28 to 29% of sericin in Kashmir silk, which is higher than any other Mulberry silk that has been examined by the present writer. This has another property, namely, that of being fairly soluble in water without the necessity of adding any soap or alkali; not completely soluble, but partially. The sericin is also sensitive to the action of the ultra-violet rays of sunlight, for on exposing part of a piece of Kashmir fabric or a portion of a skein for a few days to the sun the natural rich yellow color of the gum is faded out, the silk becoming quite white and suffering some change in its molecular arrangement, which is confirmed by the fact that when the piece is dyed and finished those places that had the faded gum are much softer in handle than the remainder where the gum had been protected from the action of the sun.

For factory purposes it was requisite that some action hould be taken to check or to retard in some degree the progress of the removal of the sericin. Broadsilks had been woven which contained harder fiber mixed with Kashmir and the call was for these in a soupled condition. Treatment that would be just enough to souple the hard silk completely de-gummed the Kashmir and the converse held good, namely, the treatment that would souple the Kashmir left the hard silk untouched. A consideration of the general principles involved suggested the use of formaldehyde as a suitable agent for putting a brake upon this too ready solubility; the result of the many experiments done was to prove that this idea was a good one and that it was possible so to manipulate the treatment that the sericin could be brought to almost any state of easy solution.

Preliminary Tests With Formaldehyde

The preliminary trial was made with a view to ascertaining the sort of result that might be obtainable, and for this purpose some of the Kashmir silk was steeped for fifteen minutes in a vessel in which was a liquor made by dissolving 10% of commercial 40% formaldehyde in water. This was done at the ordinary temperature and the silk was washed in water and then kept in boiling water for thirty minutes. The samples were dried and weighed and the amount lost was compared with a similar set of samples that had merely been boiled in water without the pre-treatment in formaldehyde. This showed the following difference:

Decrease in weight on boiling in water:

Treated Silk	3.8%
Untreated Silk	5.5%

The result of the pretreatment is here seen so far to improve the hardness of the gum that one-third part of that which would have been soluble in water is retained in the fabric. The second series of tests was to discover if the hardening of the gum was of such a nature that the effect of a soap bath would be weakened, in other words if the silk could be soupled to a less extent than if it had had no preliminary steeping. The soupling process adopted here was to work the silk in a bath of 1% of Marseilles soap for thirty minutes at a temperature of 70 deg. C. The result was found to be as follows:

Decrease of weight on soupling:

Treated Silk	3.2%
Untreated Silk	12.6%

This was a very considerable difference, proving that the gum had been hardened to the effect of soap even more than to water, consequently it was seen that in treating silk with cold formaldehyde of 10% strength we had a very potent weapon of defense against the natural "softness" of the fiber. The result properly led to a further series of trials in which the quantity of formaldehyde in the bath was varied and the temperature of soaking also while the time was retained at a quarter of an hour. No variation was made in the method of soupling which followed. In the accompanying table will be found the results of this series:

40% Form. Solution	1%	3%	6%	10%
Temp. deg. C.	Per Cent of Sericin Removed			
15	10.9	3.65	3.33	3.20
40	10.8	3.06	3.00	2.60
50	5.40	3.04	2.64	1.79
60	3.8	2.57	1.47	1.16

These figures indicate that weak solutions of formaldehyde at low temperatures do not have a very marked effect but when the heat is increased to over 40° C. the efficiency of the hardening manifests itself. The results of increased concentration and higher temperatures after that are very decisive, working up to a point when only 9% of the comparative amount for silk not pre-treated is lost.

Influence of the Soaking Period

The supposition that the duration of the soak might have some vital influence upon its efficiency proved to

be quite correct, as will be seen in the next table, which shows the effect of steeping for various periods in a bath kept at a constant strength, 6%, but with the temperature varying as in the preceeding series.

6% Form. Temp. Deg. C.	Duration of Steeping 5 Min.	¼ Hour	½ Hour
15	4.18	3.33	2.87
40	3.87	3.00	2.52
50	3.68	2.64	1.82
60	3.45	1.47	1.35

It was immediately seen that the five minutes' period was not long enough for the action of the formaldehyde to have any great effect even at the different heats, but that the lengthening of the steeping time was especially beneficial. After a full consideration of the various sides of the problem it was concluded that the quarter-hour period was best all round because the longer tended to delay operations rather more than was thought desirable. There is always a risk that half an hour of steeping will run into the best part of an hour in practice, while a quarter of an hour is something that must be watched closely and kept to strictly. The difference in the degree of hardening between a quarter and a half hour was not so great that there would be any great gain by adopting the lengthier period.

The next point that required study was the effect of lessening the strength of the formaldehyde but raising the temperature while keeping to the standardized time for the steeping. This gave somewhat surprising results as former experiments at low strength and medium temperatures had not given any indication of such strong action. The temperature chosen was 72°, that being the highest temperature this class of silk was submitted to in normal plant practice.

Temp. 72° C. Formaldehyde	Duration: ¼ Hour Sericin Lost %
½ per cent	4.60
1 per cent	2.95
2 per cent	1.56
3 per cent	0.53

This shows that even with the comparatively low strength of 3% when the steeping was done at a fair temperature the silk-gum was rendered practically insoluble in the ordinary soupling bath. It was in consequence necessary to discover if by raising the temperature of the soupling and increasing the duration of that operation it would be possible to overcome the hardening effect of the formaldehyde. For this purpose experiments were made upon the silk that had been immersed in 3% formaldehyde at 72° for ¼ hour which was worked in a similar soap to that used in the previous investigations, but for an hour instead of only thirty minutes at the temperatures indicated in the following table:

Deg. Cent.	Silk Gum Removed Per Cent
72	0.61
82	0.64
85	0.83
88	5.90
91	14.30
94	15.60

This experiment proves instructive for it shows that only when the bath containing the soap is nearing the boil does it start to have any noticeable action upon the hardened sericin, but even then, when it has been raised to 94°, it will be seen that only a trifle more than 50% of the gum contained in the silk is taken away.

Value of the Process in Using Mixed Silks

The result of the investigation, many side issues of which have not been described, has been to prove that by means of a preliminary soaking in a weak solution of formaldehyde it is possible so to harden silk-gum in a soft silk that it may be worked in conjunction with a hard silk. It is only requisite to find the best temperature for treating the hard variety so as to get the desired effect, and then to use the appropriate strength of formaldehyde for the requisite time at the right temperature on the soft silk to get the two into a state of equality. The value of this to the manufacturer who may suddenly find himself compelled to use a mixture of silks is, of course, incalculable.

It is, perhaps, necessary to utter a word of warning in certain cases. The general characterists of the "formalined" silk are much the same as that which has had no treatment—apart, that is, from the hardening of the gum to the desired extent—but it has been found that in some instances where the broadsilk has been of a thin quality the covering power of the silk has been sensibly reduced, giving rise to a scratchy, worn look. That is, of course, no more than might have been looked for, as by the nature of the treatment to which the silk has been subjected the gum has been toughened to prevent its removal and therefore it is a physical impossibility for the silk fiber to swell out to the same size as when the untreated material is included in the cloth. As to how much this may be a disadvantage and how far the hardening of the gum improves the quality of the fabric in other directions is a matter that the manufacturer must decide for himself. The work just described was done for a specific purpose and was successful, and when it was found that the cover had been reduced, other agencies were brought in to counteract the effect. This is often merely a question of making a slight alteration in the final dressing or sizing solution and may be left to the discretion of the man in charge.

Soft Water in the Kier Boil

By S. F. Alling,
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RAW cotton contains a small quantity of oils, fats and waxes together with some nitrogenous matter soluble in alkali. In addition various coloring matters are unevenly distributed throughout the fiber. Also various other substances such as starches, soaps, etc., are incorporated in the fiber during its preparation for weaving.

Every division of cotton processing following the kier boil depends upon the efficient removal of the oils, fats and waxes, etc., present in the cotton. They form a protective blanketing film over the surface and in the fibers themselves, thereby preventing successful uniformity of the various cotton processing operations.

In the kier boil cotton is boiled usually under pressure with some form of alkali. The lime boil is used but very little now. Caustic soda or soda ash in addition to a little silicate of soda, a soluble soap or a combination of these chemicals is used in the kier during the boiling out. The object of the kier boil is to saponify (make into soaps) the natural inhibatory substances or to loosen them sufficiently so that they may easily be removed from the cotton on the following wash, thereby leaving the cotton, loose, open and prepared to uniformly receive the bleach liquor, dyes, etc.

Only if 100% soft water is used in the kier boil can complete removal of the oils, waxes and fats be effected. Where hard water is used these materials are removed in part but many are converted into sticky insoluble lime and magnesium soaps and other insoluble compounds, the presence of which is fully as harmful to the following processing operations as was the presence of the original fats, oils, etc., the removal of which is the purpose of the kier boil.

How the Cotton Catches Impurities

Insoluble soaps of lime and magnesium adhere tenaciously to the cotton fiber and are never completely removed by subsequent washings. Any impurities present in the large quantities of wash water used following the kier boil quickly adhere to the sticky precipitates, the cotton actually serving as a filter for removing these impurities. In addition these insoluble soaps of lime and magnesium prevent the even penetration of the bleach solution, the result being an un-uniform bleach. Following in line the penetration of dyes is retarded and maximum evenness of shades is unobtainable since many dyes have different affinities for the so-called lime and magnesium splotches than for the portions of the cotton free of these precipitates.

Thus, we find a valuable application of soft water to the cotton industry. An ideal condition would be to use soft water throughout the cotton mill, but this would entail an enormous expenditure for the water softener installation.

Using soft water in the kier only, however, will eliminate a number of difficulties now found in cotton processing where hard water or even water containing only traces of hardness is used.

New Jersey's Experience With Benzol Poisoning*

Many Industries of the State Have Found Safe and Satisfactory Substitutes for Benzol

By Andrew F. McBride, M.D.
Commissioner of Labor, State of New Jersey

THE subject of benzol poisoning has been given considerable public attention since the end of the World War, during which period the production of benzol was greatly stimulated by the demand for toluol which was used for high explosive purposes. The early reports on benzol poisoning were largely of acute cases where workers were exposed to extremely high concentrations of benzol for a short time. These victims succumbed rapidly and in many cases lost their lives. The problem involved in acute cases of benzol poisoning is not nearly so difficult nor obscure as that encountered in the case of chronic poisoning.

In 1916 Hamilton reported fourteen acute cases, seven of which were fatal, so that experts, investigators and industrialists in the chemical industry were quite well informed on the toxic properties of benzol in cases where the exposure was acute. The British Factory Inspection department had a wide experience in benzol exposures, especially during the war period and it formulated rules to govern work in tanks or other receptacles in which benzol or toluol had been stored. These rules are:

1. The period of airing the tank must last six days.
2. The tank must be filled with water and then steam introduced till the water boils. The steam pipe must reach to the bottom of the tank and either by stirring or in some other way the sludge must be mixed with water.
3. If a tank has remained empty for some time it must be filled with water and emptied before anyone goes into it.
4. Entering a tank and working inside must be permitted only to men wearing a helmet or mask which is connected by a rubber pipe to fresh air or provided with a breathing apparatus which will allow the man to breathe normal air or a mixture of oxygen and air.
5. Every man who enters a tank must wear a safety belt with a rope attached and the other end of the rope must be held by a man outside.
6. An oxygen flask with face mask and proper connections must always be available.

In the case of chronic benzol poisoning, however, industry and medicine were not so well informed because

*Before the Midyear Meeting of the Chemical Section, National Safety Council, at Newark, N. J.

these cases are of slow origin, medical practitioners were unaware of the symptoms and, in this country at least, until very recently, they were not given to the practice of investigating a patient's employment with the idea of connecting physical ailments with his work.

Of course, there were instances available in medical records to show that chronic benzol poisoning of a fatal nature had been suffered in plants where the exposure covered a long period, but these records were not given wide publicity, for until the National Safety Council commenced its investigation, no great alarm was felt throughout the states where the use of benzol had become greater than that of almost any other industrial poison.

Preliminary Research

At the National Safety Congress held in Detroit in 1922, papers on benzol poisoning were presented which aroused so much interest that the Industrial Poisons Committee of the Chemical Section was specifically directed to undertake a special study of the problem. At the Buffalo Safety Congress in 1923 the committee made a progress report, presenting a preliminary digest and bibliography of the literature on benzol poisoning as well as a summary of what had been learned in regard to the extent of the danger to health involved. The investigation was continued during 1923, a progress report was made at the Louisville Congress in 1924, with a third progress report presented at the Cleveland Safety Congress in 1925 when it was stated "that the use of benzol (except in enclosed mechanical systems) even when the workers are protected by the most complete and effective systems of exhaust ventilation, keeping the average concentration of benzol in the workroom air below one hundred parts per million, involves a substantial hazard."

The committee then turned to the study of the higher homologues of benzene, which was completed in January, 1926, and indicated that xylol, toluol and hiflash naphtha are all relatively free from the toxicity exhibited by benzol. The committee stated at Cleveland that "the serious attention of manufacturers now using benzol should be given to the possibility of substituting one of these or other relatively harmless substances whenever the conditions of a given manufacturing process make it possible to do so." The opinion of the committee declaring that it is difficult, if not impossible, to control the benzol hazard (except where the substance is used in a completely closed system) is strongly substantiated by the experience of a large plant manufacturing coated products in the State of New York that had a series of fatalities in the department where coaters and mixers were employed, despite the most elaborate precautions, including mechanical ventilating systems and care in handling materials. This plant abandoned the use of benzol and adopted substitute fluids, which, when used in conjunction with a recovery system were economically advantageous to the industry.

In its conclusions in regard to the use of benzol as a solvent the committee stated:

In the rubber industry, in artificial leather manufacture, in sanitary can manufacture, in dry cleaning and in the use of paints and varnishes, benzol is employed as a solvent or vehicle under conditions which, almost of necessity, permit more or less evaporation of the solvent into the atmosphere. Here there is relatively little danger of acute benzol poisoning, but very great danger of chronic poisoning.

In order to minimize such hazards as far as possible, there are two general types of precautions which should be taken, tending respectively to decrease the degree of exposure and to detect and control incipient poisoning in its earliest possible stages.

1. To diminish exposure, enclosed processes should of course be used wherever possible, and, whenever containers are cleaned or apparatus repaired, the special precautions discussed in the preceding paragraph dealing with acute poisoning should be observed. Wherever employees are likely in the course of their work to be exposed to benzol fumes, as in the ordinary solvent and evaporative processes or in handling the products of such processes, they should be protected by the most effective local exhaust ventilation designed according to the following general principles:

(a) Where benzol is evaporated at room temperature, air removal by local exhaust ventilation with down draft is recommended, although in certain enclosed processes direct ventilation (from the enclosure) with upward draft may be indicated.

(b) Where localized heat is applied in the evaporation of the benzol, hoods or enclosures should be provided with updraft local exhaust. This draft should be sufficiently intensive and applied so closely to the point of origin of the evaporating benzol as to insure the complete removal of all the benzol before the heated surface is removed from the hood or enclosure.

Masks and respirators should not be relied upon to protect the worker against ordinary routine exposure to benzol fumes, since such devices cannot be made efficient without at the same time making them too uncomfortable to be worn continuously.

2. To detect incipient benzol poisoning at a stage when its effect can be minimized, it seems essential to the committee that all workers to be employed in processes where exposure to the fumes of this solvent is involved should be given a thorough medical examination before employment and re-examined, with systematic blood counts, once a month thereafter. In addition to this routine re-examination, absence from work should be promptly followed up by some person conversant with the symptoms of benzol poisoning; and the employees themselves should be made familiar with the symptoms which are most likely to occur.

No worker should be employed in a benzol process who shows signs of:

(a) Organic disease of heart, lungs, or kidneys.
(b) Hemorrhagic tendencies.
(c) Anemia or any unusual blood picture.

Any worker who, on re-examination, shows any of the following symptoms should be promptly excluded from benzol exposure and transferred to some other department of the industry.

(a) Hemorrhages from the mucous membranes of the nose, mouth or other organs.

(b) Decrease of more than the following amount from the employee's normal blood picture (normal conditions will be obtained from previous examinations of the individual employee).

(1) White cells, decrease of 25 per cent, but in no case should an employee with a white cell count of less than 5,000 be continued in benzol processes.

(2) Red cells, decrease of 25 per cent.

The investigation made by the National Safety Council covered a wide range of territory, a variety of industries and a large group of workers and its conclusions should convince even the most skeptical that coating compounds containing a benzol content that is permitted to evaporate into the breathing atmosphere cannot be used with impunity and that mechanical ventilation methods are far from adequate to produce safe working conditions. In the light of recent disclosures and a greater experience in noting the harmful effects of low concentrations of benzol, I am convinced that where coating compounds of any kind that contain benzol are used and the emanations are of such a nature as to contaminate the breathing atmosphere, that mechanical ventilation is wholly ineffective and should not be relied upon.

The Leather Industries

In New Jersey we have had a rather unusual experience with benzol poisoning cases because enormous quantities of the fluid are used in the textile leather industry which is carried on in a large way in this state, while additional amounts are used in the animal leather industry and in some other industries to a lesser extent.

The exposures in the animal and the textile leather industries are especially bad because the coated products send off emanations into the breathing atmosphere, coating materials are exposed to a greater or less degree, and workmen who have not been made sick by the compounds are difficult to convince that they are really dangerous and give off destructive vapors.

When it became apparent that health conditions in the textile leather industry were of a most serious character the Department appointed Dr. Henry Field Smith, assistant professor of industrial hygiene at the University of Pennsylvania, as a special consultant to make atmospheric tests of workrooms in the textile leather industry. The plants investigated were of an average type although some of them were equipped with elaborate systems of mechanical ventilation that were probably of a more effective type than is usually found in the average run of plants doing this kind of work. The tests were made at a time when windows and doors could be kept open and under most favorable conditions for workmen. Despite the favorable weather period, expensive and elaborate systems of mechanical ventilation, it was found in all places where atmospheric tests were made that dangerous concentrations of benzol were present and, in the light of the experience gathered by the Committee on Benzol Poisoning of the National Safety Council, were sure to cause chronic poisoning if continued over a sufficient period.

The concentrations of benzol in the breathing atmosphere ranged from 120 parts of benzol to one million parts of air, to 11,600 parts of benzol to one million parts of air. In two plants where extremely elaborate systems of mechanical ventilation had been installed in the hope of overcoming the evil, tests were made that showed in one case 840 parts of benzol to one million parts of air on a coating machine, and in another 7,600 parts of benzol to one million parts of air. In the mixing rooms where the materials were exposed to a greater or less degree, benzol concentrations of course ran higher than in the coating rooms. The mixing rooms, however, were ventilated by mechanical means and unusual efforts had been made in accordance with sound engineering advice to remove vapors by exhaust fans. After these results had been announced the department became convinced that coating compounds of this character could not be used safely and conferences were, therefore, called to secure the co-operation of leather manufacturers in the hope that the reforms needed could be accomplished by voluntary agreement.

Before proceeding with the conferences representatives of the Department of Labor visited a large plant outside the state that was using compounds on textile fabrics that did not contain benzol. This plant had passed through an unfortunate experience with benzol coating compounds and found it impossible by mechanical means to safeguard the health of workers. They, therefore, substituted ethyl-acetate and alcohol, installed a solvent recovery system which recovered about 80 per cent of the solvent materials, and found their manufacturing costs were lower than when they used a benzol compound and permitted the fluids to evaporate into the workroom atmosphere.

However, New Jersey manufacturers commenced research work in the hope of finding satisfactory substitutes that would relieve them of the heavy expense of installing solvent recovery apparatus. Nearly all the plants have succeeded in finding satisfactory substitutes that are little, if any, more expensive than the compounds that contain benzol, with the result that the use of benzol coating compounds in the animal and the textile leather industries is gradually being abandoned.

The Aldyco Corp., incorporated in Delaware with a capitalization of $30,000,000, has been organized by the Allied Chemical and Dye Corp. This new enterprise has been launched, it is announced, to facilitate the conduct of certain phases of the business of the Allied Corp.

Practical Hints on the Production of Bright Colors on Textile Fabrics

Part XXXIX

Heating With Hot Air—The Preparation of Color Pastes—Bright Colors in Printing—Various Designs and Effects—Two-Color Contrast Effects

By RAFFAELE SANSONE

LITTLE by little in modern plants the idea is growing that the old plants operated by steam can no longer answer present needs, when the cost of every treatment to which cotton fabrics are submitted has to be reduced continually to balance more expensive labor. Drying with steam has therefore become less convenient, except in machines of the finest construction in which the consumption of the heating medium is reduced to a minimum and escape steam is possibly employed.

With drum drying machines the heating for this reason is conducted in a narrow space just below the round heating shell, preventing the use of cylinders where the steam is allowed to fill the whole of the interior, and the use of internal axles. Besides this, the same steam is often passed from the first to the second cylinder, and from this to the next and following until reaching the end of the plant. Through this and similar arrangements a large saving is secured. If it is desired to increase this saving, a plant constructed on the principle shown in Fig. 1 would be of special advantage, as it can be heated entirely with hot air produced quite compactly in a small separate electric radiator, or in the absence of this, with a heater using ordinary coal gas.

In this apparatus is to be seen a series of large copper-plated iron drums, turned at any desired speed by large sprocket wheels or small pinion wheels. The interior of the drums serves as a reservoir for the hot air produced at the back by a circulation pump, the speed of which can be varied, and by a small electric heater. The hot air produced in this instance has a short distance to travel before being utilized, and is passed through all drying drums in close succession, being employed eight times before entering the heater again to bring it up to the necessary temperature for repeated use.

When starting work on the plant the operatives switch on the electric current to heat the radiator and move the circulation pump. In this way, the air present in both, in the circulation tubing, and inside the large drying drums is moved forward at a certain speed and rapidly heated, creating gradually a certain pressure, controlled with a convenient measuring device. When the correct conditions have been reached the speed of the pump and the intensity of the electric current entering the radiators is reduced to prevent a too strong action. In this way the temperature and pressure is very soon maintained constant, and the drying operations can be started by entering the first piece of cotton cloth to be dried on the drying drums, with the assistance of a cotton tape. It can then be continued for any required length of time, and even overnight if necessary, as long as the electric current enters the radiators, and the circulation pump is moved.

The arrangement permits the following advantages that are worth considering:

1. A quite small quantity of air is employed repeatedly in a closed circuit, that is, through the interior of the heating drums, in the distribution tubing, in the radiator

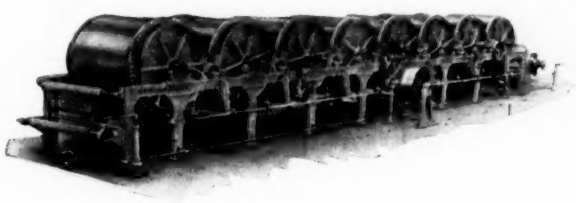

FIG. 1

and in the circulation pump, it being very seldom necessary to introduce fresh air from the exterior, and this only if leakages take place.

2. If the tubing employed for the circulation of the hot air under pressure, the heating radiator and circulation pump are conveniently isolated, very little cooling takes place when suspending work overnight on the plant, only a small quantity of electricity being therefore required on the following day for reaching the necessary temperature.

3. By raising the temperature above 100° C. the drying operations can be quickened in some cases.

4. No wetting or dirtying takes place through leakages as when using steam.

5. With a properly constructed radiator for warming the air, the heating cost represents a large saving at the end of each year, in comparison with steam heating, where losses often follow through the distance from the generation boilers.

THE PREPARATION OF THE COLOR PASTES

The preparation of the pastes required when padding with bright colors is varied in different plants, and even here the need of reducing its cost is increasingly felt.

The old methods of preparation, based on the use of wooden tubs, have been abandoned completely for this reason in the establishments operating on the most modern principles, and replaced by mechanically driven plants using double cased copper pans. These, however, are still too costly, especially if the boilers are placed at some distance and the heating medium before reaching them

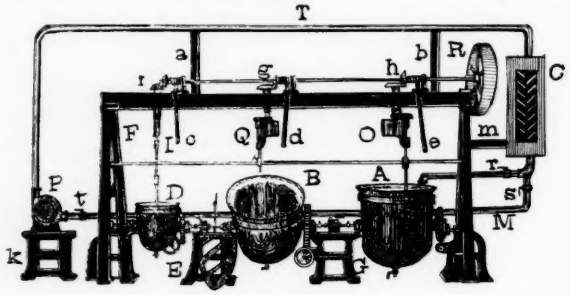

FIG. 2

has to pass through several rooms, or even in the open air.

A hot water heating plant, constructed on the principle shown in Fig. 2, would be useful for overcoming the difficulty. This consists of three large double-cased copper-plated iron pans or kettles A, B, D, the capacity of which is regulated in accordance with the scale of production of the bright colors. Such kettles are placed in special bearings G and E, so that they can be easily turned for pouring out the padding pastes into buckets. Just above is a light iron framing F, containing the three turning arrangements I, Q, O, for working agitators in kettles A, B, D, which can be started separately or stopped at any time by changing the position of the hand levers c, d, e, which work friction clutches f, g, h, placed on a horizontal driving shaft turning in supports a and b, and moved in its turn by wheel R.

The heating arrangement constitutes the most important part of the plant. It contains the iron tube M, which through taps can heat all three boilers A, B, D, or only one or two, by causing hot air to pass through the space between their double casing. Tube M is furnished with the small tap s on one side, for entering water to make its way downwards through the electric heater C. This is fixed by iron bars m, and at its top is the long iron tube T, for delivering the water pumped through tap t by centrifugal pump P. A tap is placed in this instance at the back of heater C for the introduction of water, while through tap r a portion of the hot water can be delivered into the double cased iron kettle A. Pump P is fixed on the low iron table k, which keeps it at a small height from the floor of the works.

When preparing three different lots of color paste, before switching on the electric current cold water is allowed to enter tubes T and M, between the double casing of the kettles, in pump P and in radiator C. When these parts have thus been filled, the electric current is switched on to heater C, and while the water mounts more and more in temperature, pump P is started. The different padding pastes are then prepared in kettles A, B, D, where the baths rise gradually in temperature. Before this is too high, the intensity of the electric current is reduced, so that the water cannot be heated above 100° C. or even remains below this temperature if required. The preparation of the padding pastes is then conducted in the same way as on any of the ordinary plants.

The above plant possesses the following advantages:

1. The same hot water serves repeatedly for the heating operations.

2. The cost of the heating is represented by the amount of electricity consumed, and if this is abundant and cheap, the expenses run very low.

3. The color pastes are prepared in the same way as on any other plant.

4. If necessary only two or only one kettle is employed, the others remaining idle and cold by simply closing the taps on tube M.

5. A portion of the water heated can be employed, if necessary, for the preparation of the color pastes in boiler A.

In some works it is found convenient to prepare the padding pastes in the special type of iron boilers indicated in Fig 3.

This shows two of such boilers, indicated by X and U, that have a round bottom and are fixed above special wagons, through which they can be transported on rails R to any portion of the works. For all heating operations the eight steam tubes A, B, C, D, E, F, G, H are supplied, each of which contains a tap k. The special heaters m, n, o, p, q, r, s, t, are also supplied in this case, which can be fixed at any height or lowered into the boilers by unscrewing the upper arrangements. The heaters consist of a hollow copper plate in which is fitted a copper coil, the beginning of which receives the steam from tap k, while the end is supplied with a tap for discharging all condense water formed. For working the plant, the operatives enter in the boilers the starch or other thickening agents and bring below the nearest steam tubes, after entering the necessary quantity of clean condense water. Here they prepare in the usual way, heating and agitating until the required consistance and uniformity has been obtained.

PRODUCING BRIGHT COLORS THROUGH PRINTING

The roller printing machine is a valuable means for producing bright shades and effects on cotton fabrics with

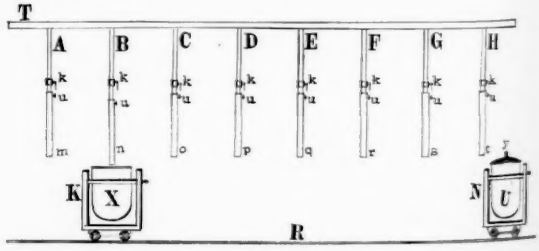

FIG. 3

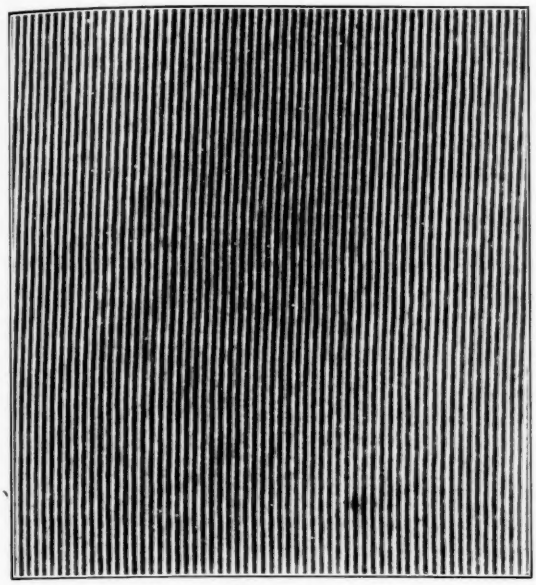

FIG. 4

basic dyes, and through it results are possible that are quite unattainable with other means, a large range of articles being possible with comparatively small quantities of coloring pastes. Besides this, to enhance the beauty of the prints some manufacturers use from the start a strongly mercerized material, or a material having a lustrous surface on one or both sides of the finest rayon, the cotton being left in the last case as a skeleton and for strengthening. Two principal types of effects can be produced, the grounding or single and the ordinary prints.

Very fine grounds are produced with:

1. One color lines or stripes.
2. One color designs
3. One color extra-shiny effects.
4. Two color contrast effects.
5. Three or more color contrast effects.
6. Ombree effects, etc.

A type of one color fine line effect is shown in Fig. 4. Here, by reducing the size of such lines to the lowest possible degree, and printing on a highly mercerized white cotton fabric with suitable pastes containing dyes like Rhodamine B, Rhodamine 6G, Auramine II, Methylene Blue B, Brilliant Green, Methyl Violet 6B, a mixture of Auramine II and Methylene Blue B, a mixture of Rhodamine 6G and Auramine II, etc., a very bright fabric results in which the ground does not appear printed, but rather padded or dyed, and it requires a strong magnifying glass to detect the real process. In this case, the thickening in the printing paste can be eliminated to obtain softer articles, or can be left for filling to a certain extent.

The construction of structure of the cotton fabric can also help matters. Thus if it is a warp sateen, and the printed lines are made to run down the length of the pieces a very strong brightening follows, while if on the contrary a fabric is treated with the sateen effect running weftways, the thin line shines out much less, as the shine on the material runs principally across the pieces. Matters can be assisted, however, to a certain extent by scheinering the goods.

The finishing operations to which the cloth printed as above are submitted can also contribute towards the beauty of the final articles. Thus, a fine effect can be obtained with a smooth polish, which is, however, rendered quite extraordinary if the same article is treated on a schreiner calender, for in this instance the very thin shiny lines impressed will work together with the thin colored lines.

The production of the above material requires a one-roller printing machine having a coloring cylinder with very fine lines. If this is composed of unsuitable material repairing will often be necessary, as the very fine engraving can easily suffer damage or wear, producing partial smearings, that even if hardly visible to the naked eye in some cases, are all the same quite sufficient to take away the fine appearance and uniformity of the goods.

If the necessary machinery is available, the above thin line effect can be produced simultaneously on both sides of the cotton fabrics, taking away the greater part of the appearance of a printed article. A certain variety can be introduced, if necessary, by using the thin lines wider apart, closer, or of greater or less thickness than those on the other face of the cotton fabrics, or by adopting other special changes.

Another one color printed effect of great attraction, especially as it offers a certain novelty, is composed of thousands of very thin lines broken off at varying intervals that allow the white ground to show, as if the material were covered by another very loose fabric. Besides this a brightness of different nature to that of the first article is obtained as above, where the white has also less tendency to appear through or among the colored lined portions, owing to their great closeness. Quite a large rang of other special printed effects can be produced by

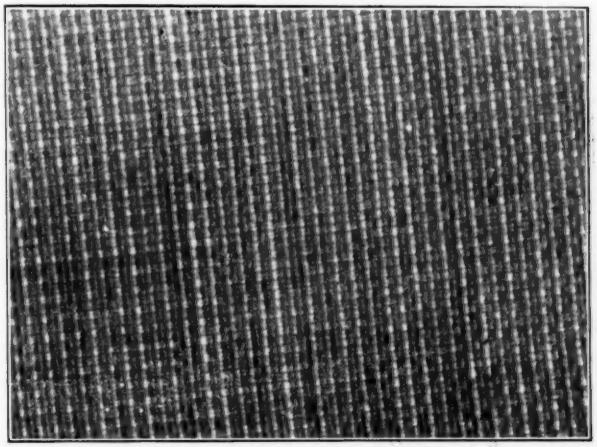

FIG. 5

stripes placed in close pairs at a regulated or different distance from one another, with lines and stripes of the same color which alternate or do not alternate one another; or that run warp and weftways, etc.

When very fine one-color design effects are produced, a large range of patterns is possible, the appearance of which can often also be varied by a difference in the construction or structure of the material. One of the simplest grounding designs to produce on the roller printing machine is indicated in Fig. 5. Here there are two lots of pairs of lines, a thicker that traverses the width of the material, and a thinner that runs down its length. Here the white ground which remains visible is extensive and greatly influences the combination resulting when the goods are seen from a distance.

An interesting article is produced by printing very small squares at the same distance from one another all through the piece, and under conditions that no striping can follow. In this way the cloth assumes a strange appearance, the cause of which can only be controlled by close observation with a suitable manifying means. Very small rectangles, triangles, circles, stars, etc., can also vary the effects, as can the printing of colored blotches. If the latter have the shape of hexagons the effect shown in Fig. 6 results. In this instance the space left for the white ground is but small, and the results can be varied or changed by increasing its size, or reducing the dimensions of the blotches and regulating their distance apart. Another design of very strange nature, that can be printed for grounding mercerized cotton fabrics, is shown in Fig. 7, where, on a ground of very small white squares, a small design of a certain thickness is produced.

One color extra-lustrous effects are another achievement of great importance in the printing of white mercerized fabrics. These are obtained on a transparent rayon covering, by using color pastes which dry transparent, and can contain very thin colored lines, stripes or small dots or designs that can be seen through, and shine much more than if the material has been schreinered as the latter remains quite vitreous. Such effects can be enhanced further by printing colored lines or stripes in such a manner that they leave visible a certain extra quantity of the white ground,

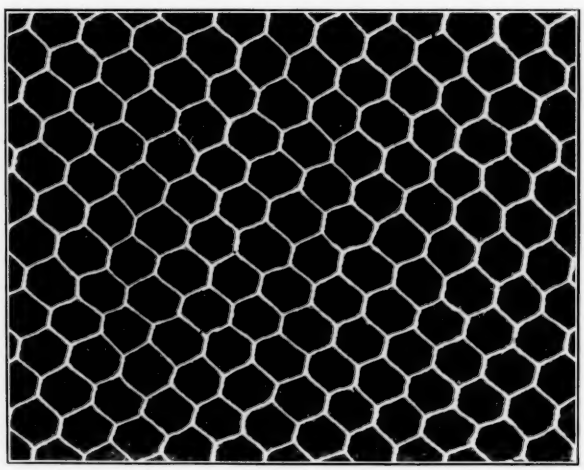

Fig. 6

The Two-Color Contrast Effects

All prints indicated so far are surpassed by the beauty of the ground when using two or more contrasting colors, by which a great variety is also possible. Very fine com-

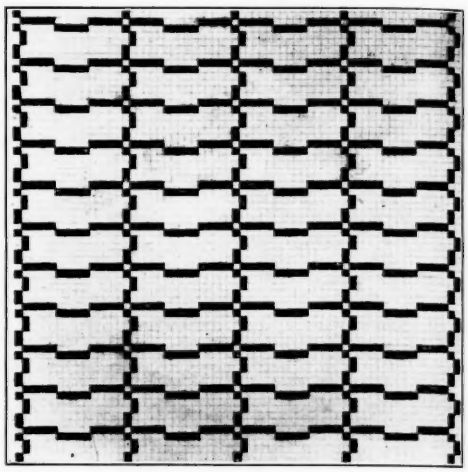

Fig. 7

position grounds are produced by printing together one stripe of one color and one stripe of another, the greater variety being introduced in this instance by increasing the width of the stripes, rendering one line wider than the other, using series of lines of one color side by side with series of another color, series of stripes of one color alternated with a single stripe of another color, etc.; the white ground being allowed to show in all cases.

With some articles small squares of one color can be introduced in larger squares of another color, in the middle and between which the white ground is visible more or less strongly. In this way, under the most convenient conditions, the cotton fabric appears to possess only a single color. The composition shade produced, to be perfect, must be quite small, and each pair of different squares has to be very close together; and these can even touch one another.

Another class of effects containing two printing colors contains a design of one color repeated continually at short distances through the piece and surmounted by a design of a very different color that contrasts very markedly with the first. In this way under convenient conditions the two colors blend in one. In some fabrics undulated lines are printed in such a manner that one is of one color and the other of another, the contrast thus obtained being rendered more or less pronounced by the

(*Continued on page* 578)

Proceedings of the American Association of Textile Chemists and Colorists

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The Structure of Individual Fibers*

By CHARLES F. GOLDTHWAIT
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THERE are two broad classes of knowledge that are especially important to members of this Association. One is the definite, precise knowledge of just exactly how to produce specific desired results, such as methods of bleaching rayon, applying basic dyes, or any other of the many things that the textile chemist or colorist is called upon to do. The other is the more fundamental knowledge upon which such processes are really based. We may go on for years practising the art of treating textiles and yet know very little of the underlying science. It seems self evident, however, that the knowledge of the most minute properties of textile fibers is extremely important. It can be expected to lead to improvement in process or product and to be particularly helpful when encountering trouble.

The present purpose is to review briefly some of the more up-to-date ideas on the structure and behavior of textile fibers, for what can be done with fibers depends most fundamentally upon how they are made. This paper may also be considered a mild form of propaganda, for much more of this sort of work is needed. The larger share of the knowledge already existent is of foreign origin, and much of it is in publications that are not readily available.

The most important of all textile fibers is cotton and, appropriately, it has been most subject to fundamental research. As the plant grows, the new seed follows the blossom and then comes the fiber. Some of the cells in the outer layer of the embryo seed coat begin to protrude. (Fig. 1.) These are the beginning of fibers and they proceed to grow out at the rate of twice the diameter added to the length every hour. This continues for about twenty-five days. Then the growth mechanism suddenly changes. Up to this point the fiber is a very thin walled tube. Now the wall begins to thicken from the deposition of cellulose inside it.[1]

Sir W. Lawrence Balls, who has described these phenomena, has made a very extensive study of Egyptian cotton. In Egypt the cotton plant grows under

*Paper presented before Philadelphia Section, February 24, 1928, but not published with the report of that meeting.

very extreme conditions, on irrigated land and under intense heat. During the day the plant evaporates enormous quantities of water to keep itself cool, the same as we do when we perspire. Balls suspected that the fiber might do most of its growing at night and little if any in the day time when so much of the water was evaporating from the leaves. He reasoned that the fibers might show growth rings like those of a tree, for the latter are merely the marks of the rest periods that the tree has in the winter.

He became interested in this specific line of research from an accidental observation that suggested growth rings. In following it up he first swelled fibers by a viscose reaction to from ten to forty times their normal diameter. On applying the microscope to the chemically magnified cross-sections he obtained final magnifications of about twenty thousand times and

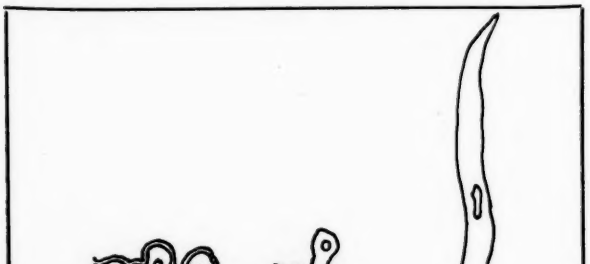

FIG. 1.—Here A and B indicate roughly (after Balls), how the cotton fibers start as enlarged cells. They grow through the stage indicated by C until the length of a fiber is between one and two thousand times its diameter. The diameter, or width, is actually about one twelve-hundredth of an inch.

was enabled to count twenty-five to thirty growth rings in a fiber or one for each day during which the fiber wall was becoming thicker.[2], [3]

Thus was established one element of the structure of cotton fibers, concentric layers. The writer does not recall at the moment that the layers have been observed, or whether they are so pronounced in American cotton. It is probable that they exist in all cotton and contribute to its useful physical properties.

SPIRAL UNITS IN FIBERS

The next feature of the structure of cotton is even more important, the minute spiral units which enter into it in much the same way that fibers form a yarn. In spite of their very different origin within the plant, cotton fibers which are seed hairs and flax fibers which grow in the bast of the stem both show a "basket"

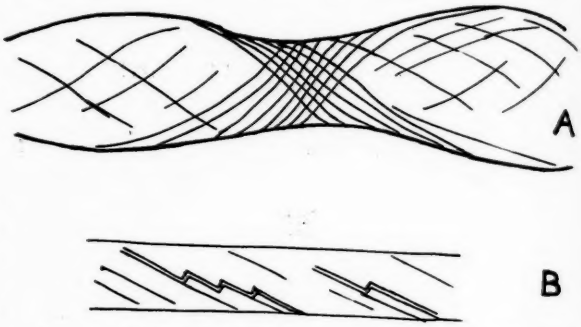

FIG. 2.—In A are shown diagrammatically some of the fibrils in a swollen cotton fiber. In B are shown some of the fibrils as they appear after treatment with acids. The new set of lines at approximately right angles to the first may be an indication of breakage across the fibrils, and a possible cause of tendering. The spiral fibrils are at about thirty degrees to the fiber axis.

structure when suitably viewed under the microscope. (Fig. 2.) It is not, however, an actually intermeshed basket but a spiral with the back and front both showing owing to the transparency of the fibers.

According to one technic they are made more readily visible by pressing between a cover glass and slide. They split apart, spread out and come more nearly into the same focus. In splitting, the cracks run right down through the whole wall thickness indicating natural lines of cleavage which no doubt have a close relationship to the internal surface that is effective in dyeing.

While the spiral structure is of very apparent value in a unit used for yarn making it has no very evident use in the cotton plant. In flax, however, there is a

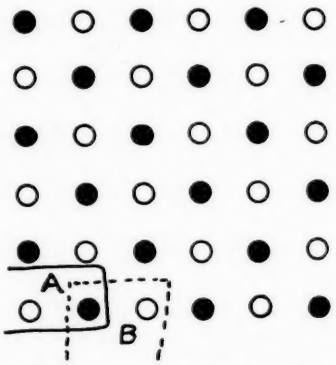

FIG. 3.—This figure represents a layer of atoms in a crystal of salt. The light circles represent sodium atoms and the dark, chlorine.

definite use for the spirals for the fibers form a sheath around the whole stem and the spiral spring effect keeps the stem from breaking down and helps it to spring back when bent by the wind.

There are estimated to be 2,000 spiral units in a cotton fiber, and the fibrils in a single ounce of cotton would reach five times around the world. Even with this minute size we are still far from the ultimate cellulose unit of structure.

The spiral fibrils of cotton do not twist in the same direction throughout the length of the fiber but reverse at irregular intervals.

Fibers are considered colloidal materials but recently they have been described as crystalline. A crystal of salt (Fig. 3) is virtually one big molecule

FIG. 4.—This diagram indicates how the crystallites in a spiral fibril (greatly exaggerated) may have a great variety of positions and still all point in the same general direction. The broken spiral is imagined as seen through the fiber.

because the sodium and the chlorine are placed as shown, then one layer behind another to build up the crystal. One cannot say whether the atoms at (A) constitute a molecule of salt in the usual sense or those at (B) or any other pair. The present-day view is that they are not grouped by pairs but are all one whole and that salt does not dissolve in the form of molecules but directly as Na and Cl ions. Thus the molecule Na Cl is not needed and either the ion or the whole crystal serves as a unit.

Similarly we may yet look upon the individual cotton fiber as a single crystal.

Now how can a material be both colloidal and crystalline at the same time? The conception, colloid, has changed from a material to a state of matter and more recently to a behavior. X-ray studies of colloidal materials, if so-called, are showing that they have crystalline structures. The properties of colloids are very largely the properties of immense surfaces so if the crystals are fine enough they have sufficient surface to act like colloids.

Barium sulfate is crystalline but it can be prepared as a colloidal gel. The ultimate particles in the colloidal gel are still crystals.

These are crystals in the ordinary sense, with sharp angles and smooth faces. But, applied to fibers and such materials the term crystalline has a broader meaning and may be misleading. What is really meant is that the material has a definite orderly structure. We speak of liquid crystals, which do not have the ordinary crystal properties, but are a manifestation of some fairly stable orderly arrangement in a liquid. Similarly we have an even more substantial arrangement in our fibers, and it is now called crystalline.

Without going into the X-ray method of studying crystals or fibers we can say briefly that X-rays suitably directed through a crystal toward a photographic

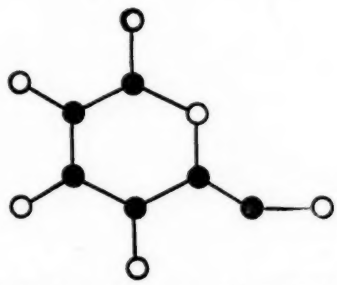

FIG. 5.—The amylene oxide type of formula for the glucose building-unit in cellulose. Dark circles represent carbon atoms; light circles are oxygen; hydrogen atoms are omitted. See Fig. 6.

plate form a pattern of spots. If directed through a powder of minute crystals the planes in the crystals that produced the spots are effective in all directions and give a series of rings. In a cotton fiber the condition is roughly half way between, for the crystals are half arranged. They all point in one direction, roughly along the fiber axis but they are not all the

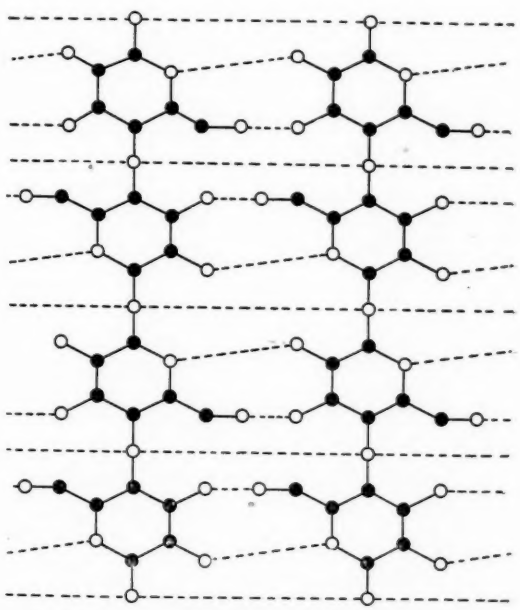

FIG. 6A.—This figure shows how the glucose units are joined together in chains. Solid connecting lines represent primary and broken lines secondary valences.

same side up because they follow the spirals around. (Fig. 4.)

Crystal Units in Cellulose

The above is the outgrowth of much well known research by various workers in several countries.

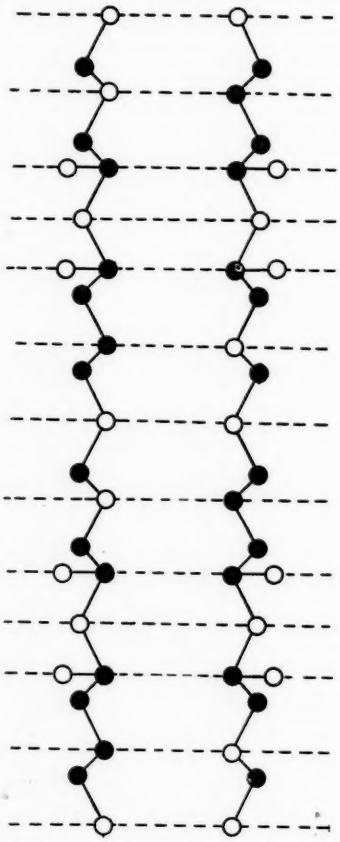

Fig. 6B.—This is a side view of the chains of glucose units in ramie cellulose.

Recently Sponsler and Dore of California have gone a step farther and pictured for us an exact arrangement of cellulose molecules in ramie fiber. It seems to fit most excellently many of the physical as well as chemical properties of cellulose in general.[4]

Cellulose is made up fundamentally from glucose and their work showed the necessity of giving it a ring formula. (Fig. 5).

Then by the X-ray studies they succeeded in finding an arrangement whose internal dimensions satisfied the X-ray requirements and whose general form accounted for chemical reactions.

The rings appear to be united flatwise (Fig. 6A) but considering the fiber as a whole they are at different angles. (Fig. 7) Viewed from the side the chains appear as zig-zag lines (Fig. 6B). These run lengthwise of the fiber and the units in the chains are regarded as being united end to end by strong primary valences, which give the fibers their strength. Sidewise they are united by weaker secondary valences between the various oxygen atoms.

These authors do not seem to regard the chains as extending spirally around the fiber axis but it would seem that they might be spirals to bring them into line with cotton, flax and hemp.

Eight glucose units are required to form the structural or crystal unit, and the cell wall is 40,000 units thick.

An interesting point is that there are three hydroxyl groups open to chemical attack and these can react without destroying the fibrous structure because the main primary bonds are not affected, and trinitro cellulose is still fibrous in form. The triacetate does not retain the fibrous structure as well, apparently because the larger acetate groups crowd the chains too far apart.

Cellulose fibers swell in water, caustic soda and other so-called swelling agents, apparently because these materials are absorbed and force themselves between the chains when they are attracted by the oxygen atoms.

Gelatin swells in all directions in water because its structure is not directed. Fibers swell in diameter but not in length because up to a certain point for each condition the swelling agent or water can only spread the chains or fibrillar elements sidewise. If they are spirals they will contract in length, as cotton does, rather than swell, lengthwise. They are of course disrupted when cotton dissolves.

Briefly summarized, cellulose fibers consist of chains of molecules which are really glucose united side by

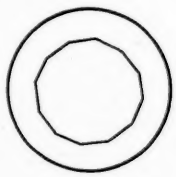

Fig. 7

side into fibrils which can be seen under the microscope, and these into the fiber itself. In dyeing and some other processing it is undoubtedly not merely the external fiber surface that is effective, but also internal surface that is available or is made available by some treatment.

In a recent discussion[5] it was brought out that fibers appear to have pores. There is strong evidence

for them in cotton, flax and wool. However, F. T. Pierce states that the latest evidence indicates that they are formed in cotton during absorption. The first molecules of water that are drawn between the cellulose units by their strong attraction may separate the layers as a marble would separate the pages of a book leaving much extra space and exposing new internal surfaces.

Some Effects from Cotton Structure

Mercerization is said to correspond to a higher degree of dispersion. We can only understand a higher degree of dispersion of a fiber, if it is still to remain a fiber, by such an increase in available surface for dye effects, moisture regain and chemical reaction or absorption.

In processing, yarns or piece goods become harsh or soft from acid, soap or whatever the treatment may have been and we say it was dried too hot, had too much acid or offer some other reason which is oftener than not no reason at all. Consider a cotton yarn, if it is stretched wet and then dried it may become stiff and wiry. This may be merely because the fibers have been forced close together and "set" in that position making the yarn less flexible. Similarly the element in the fibers are affected by various treatments and respond in terms of "feel" in yarn or pieces.

Even since this paper was originally prepared the spiral fibrils have been used to interpret strength effects in yarn and cotton piece goods.[6] Cotton yarn, for example, is stronger when in a humid atmosphere than when dry, because the fibers swell under the influence of moisture, press together more tightly and increase the friction between fibers in the yarn. The individual fibers also seem to act in just the same way. Swelling of the constituent fibrils brings them closer together and the binding effect makes the fibers stronger. Thus humidity influence the two elements of yarn strength, fiber strength and fiber slip.

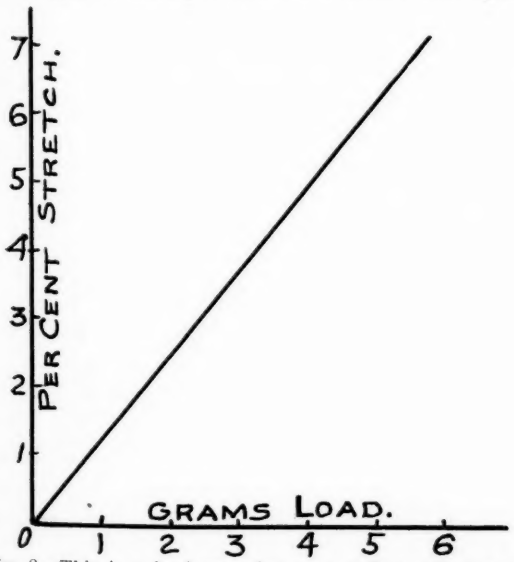

Fig. 8.—This is a load-extension or a pull-stretch curve for a single cotton fiber. For example, a pull of 4 grams stretched this fiber about 5%. Fibers vary greatly and the curves are not always straight lines.

Further evidence of the effects of fibrils is the fact that cotton fibers are made stronger by twisting, in the same way that the strength of yarn is increased by twist (up to certain limits).

Mercerized yarn and cloth will furnish a final example of the fibril effects. In the article quoted and in the present author's own experiente, humidity has but very little strengthening effect on mercerized materials as compared with unmercerized. This is because the fibrils become swollen and in the process their strengthening effect on the individual cotton fibers becomes permanent. Humidity cannot add further to the effect.

Similarly with yarn or cloth the swelling of fibers and applied tension cause a closer union of the fibers and a strengthening that is not greatly increased by humidity.

The separate fiber obviously has a structure much like that of yarn.

Another View of Fiber Structure

There is another point of view that deserves serious attention although it seems to have been rendered somewhat unnecessary by some of the work on cellulose that has been already reviewed. This is the two-phase structure based on the crystallites that are revealed by X-ray studies and a surrounding viscous or cementing medium. Herzog [7], for example, offers the explanation that under the influence of high humidity the moisture softens the embedding substance and allows the crystallites to draw apart, thus accounting for the greater extensibility of cotton under these circumstances.

At minus 185° C. the tensile strength of a cellulose film does not alter but its extensibility disappears. This is explained by the embedding material becoming hardened to a glass-like mass. Thus while various phenomena can be explained by its aid, it implies more than one kind of cellulose in the main body of the fiber. The X-ray and spiral structures that have been outlined do not seem to leave any place for, or to require such an embedding material. Donald B. Anderson of Ohio State University states very definitely[8] that there is no embedding material between the spirally wound crystalline fibrillae in flax.

The general idea seems to fit better with wool, silk and rayon as we shall see.

Although flax fibers grow so differently from cotton, the structure of the separate fiber is almost exactly

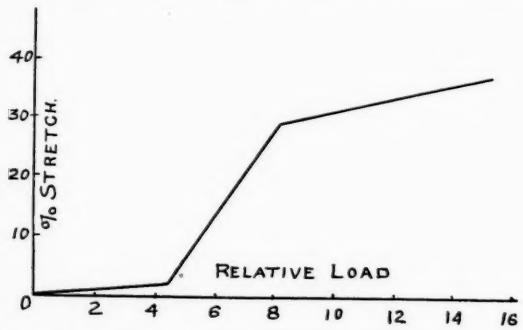

FIG. 9.—The type of load extension curve obtained from single wool fibers.

like that of cotton. Either can be covered by a flax man's description of his fiber as a "concentrically lamellated spiro-fibrillar crystalline aggregate with colloidal properties," a very compact morsel of food for thought.

Single cotton fibers will stretch about six or seven per cent, as represented roughly by the curve (Fig. 8) which is quite uniform. This stretch is due to something, straining of the chemical bonds, lengthening of the spirals accompanied by their moving in toward the axis of the fiber or possibly a tendency for the zig-zag chain to pull out straighter. At any rate the effect is relatively uniform as the load is increased.

INTRODUCING WOOL

Wool is quite different in its behavior with tension as shown in (Fig. 9). The two sharp changes in the curve indicate changes within the fiber as tension is increased and are therefore indications of fiber structure [9], [10].

The cotton fiber is a single plant cell. The wool fiber is made up of many cells which fall into three classes. The outer ones have taken the form of scales, the intermediate ones are long and spindle shaped and form the bulk of the fiber, while the inner cells which suggest the pith of plants may contain air and pigment.

When wool is stretched the cells do not slip one upon another. Rather, the whole fiber stretches so that its behavior represents that of the single cell. (Fig. 10.) The load extension curve therefore furnishes clues to the cell structure.

The wool cells are known to contain fibrillae which are largely parallel to the length of the fiber but are sometimes haphazardly arranged. There is not the exact knowledge here that we have of cotton.

From all the evidence the wool cell is believed "to consist of an elastic cell wall, enclosing a fibrillar structure whose interstices are filled with a viscous medium." To make it plainer, the first section of the curve (Fig. 9) represents actual stretch of cell wall and fibrillae; then at a yield point the process changes and fibrillae are rapidly drawn into line, perhaps by rotation, finally when this is accomplished the stretch proceeds slowly again up to the breaking point.

There is very much more to be learned about wool, but it is substantially a gel structure. This, with its plasticity and elastic properties, is largely responsible for the versatility of wool in finishing.

It is a curious fact that wool in a saturated atmosphere, that is, wet, will stretch 70% beyond its original length and ultimately return to that length. If stretched in ice water, it takes twice the force to produce the same extension. This means that the wool is twice as strong when wet at this low temperature. These phenomena are due to the wool gel becoming less viscous and more readily deformed when it takes up water, but setting when chilled. These and related properties have long been applied in the every day wool processing and promise soon to be very much better understood.

SILK AND RAYON

Silk structure is another story, about which almost nothing seems to have been learned. Silk is still spoken of as structureless. The individual fiber does, however, consist of finer fibrils and judging from its strength and the X-ray evidence these in turn may be

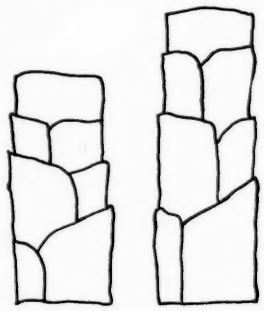

FIG. 10.—Representation of a wool fiber before and after stretching 25%. (Mark.)

made up from crystallites firmly joined together and possibly embedded in some more viscous medium.

One of the important possible uses of all this theory is in the improvement of rayon. It consists of cellulose crystal units or groups of them arranged in a more

or less haphazard manner. The formation of the ordinary filament seems to have arranged some of them so that they have a firm hold upon one another. The X-ray pattern indicates that there is a certain amount of this structure. It can be improved by manipulation of the fibers, and continued research may finally indicate how more of the cellulose crystal units can be preserved in the rayon, coaxed to arrange themselves in proper order and thus assisted to unite again into a stronger fiber.

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ASSOCIATION BADGES

The lapel button badge illustrated herewith is worn by members of the American Association of Textile Chemists and Colorists.

The three "rings" are enameled in red, yellow and blue, respectively, and the initials and border are brought out in gold. The general effect is exceedingly attractive.

Badges may be secured at $1.50 each by addressing the Secretary.

WALTER E. HADLEY,
5 Mountain Avenue,
Maplewood, N. J.

Colors in Commerce

Differences in Color May Be Material or Immaterial Consideration—Simplified Practice May Be Beneficial

By Edwin W. Ely,
Division of Simplified Practice, Bureau of Standards

NOWADAYS there is an increasing number of manufactured products in which color has become a pronounced factor. Automobiles, stoves, kitchen utensils, tools, hat bands, stockings—all have a claim on the spectrum. Whether this means that we as a nation are declaring our collective and personal optimism of the "rightness of things as they are," or whether some other motive urges us to develop a sense of contrast, the fact remains that we are rivaling nature herself in the language of color.

The question has been asked recently: "Is the wide variety of shades, hues, tints and colors a repudiation of the principles of Simplified Practice, and cannot simplification be invoked to curb or at least arrest the tendency to apply color to everything?"

In answering this question it will be appropriate to first define Simplified Practice. Simplified Practice means the reduction of variety in sizes, dimensions and *immaterial* differences, of everyday commodities as a means of eliminating waste, decreasing costs and increasing profits and values in production, distribution and consumption.

The reader's attention is called to the word *"immaterial"* in the definition, and the fact that it is italicized by way of emphasis, for in that word rests the heart of the simplification movement.

Differences in color, as applied to a given commodity, are an "immaterial" or a "material" consideration according to the viewpoint from which the problem at hand is regarded. If color is considered in conjunction with articles of ornamentation, or commodities that provide a vehicle for the expression of personality and personal taste, then the question resolves itself into one of *aesthetics*. These differences may not be vital, economically. They are important, nevertheless, and may be regarded as "material" differences.

Repairs and replacements which require the harmonizing or blending of colors create a situation which is not essentially different from that presented in the problem of interchangeability in machines. Colors must match, harmonize with or be complements of each other; parts of a machine must "fit." Again we are faced by "material" differences.

If color is regarded in connection with articles of utility, then the aesthetic side is less important while the economic side is more heavily stressed. Will a tool or any other useful commodity perform its destined function just as well while wearing one color as another? Will it perform that function less expensively if manufactured in a simplified range of colors, or with no color at all, than is the case when it is coated with color?

Assuming that color is a side issue and the question of price primary, it may be said that a clear case of "immaterial" differences is exemplified. In such circumstances simplification should offer tangible benefits to all concerned without in any way interfering with personal taste, or the expression of individuality in design and creation.

An analysis of this kind might or might not be considered practicable by an industry, in view of other controlling factors. At any rate it will be interesting to here set down the facts that attend the production of commodities in a wide variety of colors:

"The *manufacturer* must tie up his capital in extra equipment in order to maintain production of the full line of colors. His inventory is rendered more complex and expensive, and he must have additional storage facilities. He is manufacturing for an uncertain demand and he is confronted with a variable factor of style which he never suspected would intrude itself into his business. His commodity may be a humble article of utility, but he now shares with the manufacturers of clothing the speculative risks that go hand and hand with styles. These are all overhead costs and they eventually find their way to the consumer.

"The *distributor* is faced with problems of inventory, heavy investment to meet all demand, extra space and additional rent. He adds his costs to those which have been passed on to him by the manufacturer, and again the consumer comes into the picture.

"The *consumer* in many instances is confused by the wide range of choice that is presented to him. Many times he desires only utility, but he pays for an ornament."

If the producers, distributors and users are of one mind in regard to the economic advantage of conforming to a simplified list of colors, it would be possible to establish such a list by the unanimous consent of all concerned. With all elements in an industry co-operating, it should be possible to arrive at conclusions that would prove mutually satisfactory.

The situation may be summed up as follows:

Overdiversification is wasteful.

Overstandardization stultifies and restricts.

Simplification, intelligently and moderately applied, offers a middle ground or happy medium between these two extremes.

OPTION ON WATERPROOFING PROCESS SOLD

Benjamin E. Bronson, New York exporter and importer, is reported by the London Bureau of the Daily News Record to have secured an option on a process which renders any texile fabric impervious to water and fire, invented by Dr. Ernest C. Ryan, of London. Official tests of the process in connection with rendering airplane fabrics snowproof were recently carried out.

AMERICAN DYESTUFF REPORTER

Devoted to the use and application of dyestuffs and the mechanical equipment incidental thereto.

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BEYOND THE ENGLISH CHANNEL

TWO weeks ago there appeared in these columns a criticism of the policy of certain American financial interests that are lending their support to the chemical trusts abroad. That policy was branded as shortsighted because the assistance which our bankers have recently extended to European interests is a backhanded blow at the American dye and chemical industry. Wall Street, it was declared, is the King Midas that turns into gold the expansion plans of the foreign chemical trusts.

We cited as an example the case of the recently formed Finance Company of Great Britain and America, which was the outgrowth of an agreement between Imperial Chemical Industries, Ltd., Britain's strongest industrial combine, and the Chase Securities Corporation of New York. "The guardian of national safety," as Sir Alfred Mond styled the I. C. I., was thus linked to an enormous reservoir of American capital with which it will be able to develop the numerous enterprises under its control.

It was not the REPORTER'S intention, however, to single out this particular case as the most reprehensible result of the banking policy we criticized. That case happened to be more widely discussed in the press than others. But in line with their policy the international bankers have made other deals with European chemical interests—deals that deserve fully as much publicity as the I. C. I.-Chase Securities deal received.

In other words, the great American idea of capitalizing industry for productive power, and the financial support of that idea lie at the base of more than one of the large enterprises reared this summer in the European chemical world. Both the idea and the money have gone beyond the English Channel to the banks of the Rhine and the Seine, even unto the shores of the Adriatic.

The machinations of a powerful cartel of continental chemical interests will be the more successful for the timely aid extended to it by Wall Street financiers. A block of bonds floated recently by the I. G. to the tune of forty-three million dollars has been shouldered by our benevolent brokers; and while it may sound like quibbling to mention the fact, it should be called to the attention of those who ought to know such things that almost another million in good United States currency brought to our shores a bundle of stock marked with the insignia of the largest French chemical trust, Kuhlman Company, Ltd.

Italy recently joined the line-up of powers comprising the European chemical cartel. That huge industrial group has every reason to be elated over this increase in its family. The German I. G. and certain Swiss chemical interests recently formed a new subsidiary, the Societe Internationale pour Enterprises Chemiques, its capital being put at twenty million francs. This move is characterized by one Berlin observer as a new basis for further negotiations among the chemical interests of Europe. A Swiss-German dyestuff agreement on sales and markets may, it is stated, be the result. That, surely, is important.

What is the significance of all these various movements within the foreign chemical industry—their significance to the United States? Despite our productive technical researches in chemical manufacture and our scientific achievements in the development of many new products, we have not kept abreast in these activities with the gold-laden trusts of Europe. We have depended too much upon the narrow margin of security afforded by our present tariff. This dependence has made us indifferent to the menace of Europe's gathering forces. As a result the international bankers have turned the stream of their financial ventures across the Atlantic and have helped the foreign interests to erect colossuses that we must now face.

The most obvious move open to the American industry has been suggested too often to require any lengthy explanation. Those who have argued against this move have pointed to the Sherman Anti-trust law and similar legislation as the obstacle to any attempt at a merger of American dye and chemical manufacturers. But have other large industries been balked in laying plans for consolidating their units? Everyone knows that in this country large industrial combinations control our output of steel, petroleum, rubber and other commodities and that various utility corporations and banking interests are continually merging for strength and efficiency. Is it logical, in the light of these conditions, to assert that our chemical industry must expose an unorganized front to its foreign competitors in the world's markets? Is it the most sensible thing to depend solely on a protective tariff? Is it not clear that no tariff at home can ever help the domestic manufacturer in his conflict with the

European trusts in the chemical markets of China, South America, Canada?

We know that the international bankers are working against the interests of the industry in this country; we know that Europe's powerful combinations of chemical producers are reaping the full benefit of that financial support. What kind of tariff revision we may expect in the next Congress nobody knows. But in the full light of all these factors nothing is more certain than the need for a more united American dyestuff and chemical industry.

CHEMICAL RESEARCH IN GREAT BRITAIN

CENTRALIZED control of governmental research has been proposed a number of times as a solution for the problems in departmental jurisdiction that occasionally arise among our scientific agencies in Washington. Such a method has been in operation in Great Britain for the past eight years and some of the experience gained in its successful administration there might well be studied for possible application by our own government.

We are indebted to Sir James C. Irvine of the University of St. Andrews, whose recent lecture before the Institute of Chemistry in Evanston contains many thoughtful commentaries on the status of chemical research in Great Britain. His government, Sir James reports, has lately taken an entirely new attitude toward science and has become a generous patron in its support. Directly after the war a Department of Industrial and Scientific Research was established as an official branch of His Majesty's Treasury and now has direct authority for the appropriation of more than $2,500,000 a year for research purposes.

It is particularly significant that this governmental department is made up wholly of scientific men. As each research project is proposed it must be passed upon by these men who are especially qualified to judge the probable scientific and industrial value of the work. And since the department holds the authority for the appropriation of funds, it can assign the project to the particular governmental or industrial agency best qualified to carry it through to completion.

Most of the major projects are assigned to two large government laboratories, one of which deals primarily with customs and excise while the other is a research organization comparable to our Bureau of Standards. Associated with the latter is the fuel research station where approximately a million dollars a year is now expended on the chemical and chemical engineering investigation of fuel production and utilization. But the interest to the British Government does not end with the governmental institutions for it is extended through substantial grants of funds to a number of industrial research associations. British industries, through their respective associations, submit their more fundamental problems to the department and the accepted projects are assigned and supported by public funds up to the extent of fifty per cent of their total cost. Governmental appropriations for this purpose total about $400,000 a year.

Nor is the type of investigation which Sir James calls "pure, disinterested research" neglected. Last year $170,000 was granted to young graduates to enable them to continue their studies at the universities. Work such as that of Professor Bone on high-pressure combustion and the researches of Sir William Bragg are being supported to the extent of $35,000 a year. Many similar examples might be cited but these are sufficient to indicate the comprehensive views and policies of the governmental department.

Such an attitude toward research and its generous support by the British Government is indeed a creditable record in a country already severely handicapped by heavy taxation. It is a record that can be profitably studied if the research activities of our own Government are to be co-ordinated and adequately supported for more effective results.—*Chemical and Metallurgical Engineering.*

EXTRACTORIALS

The amalgamations that have been made within the last ten years have been largely the result of "cutthroat" competition that has resulted from the excessive productive capacity which was a legacy of the war, and which threatened many industries with financial suicide. They are the result of a very natural desire on the part of industrialists to obtain a fair return for their efforts, which cannot be obtained under conditions of unrestricted competition aggravated by excessive productive capacity.—*A. P. M. Fleming, in Manchester Guardian Commercial.*

The country possessing the most efficient chemical industry possesses also the most efficient instrument of war. No peace treaty or visiting commissions can control or even detect research designed to furnish lethal agents for the future and this research may be going on anywhere in preparation for the next war.—*Sir James Irvine of St. Andrews University at the A.C.S. Institute.*

Color is one of the most important properties of matter; it is, in fact, the one property on which we depend for our knowledge of the world about us. The form of objects is only distinguished to our eyes by the contrasts existing on different parts of their surfaces and with their backgrounds.—*Dr. E. W. Pierce.*

There are no very great difficulties about the dyeing of rayon with the production of colors of any desired hue or degree of fastness. The chief difficulties are those of mechanical handling, which can be overcome by effi-

cient care, and of suitable selection of working materials, which can be made once, for all, goods of the same class.—*Carl Hirstine, in Rayon.*

Every man should try to put over the best that can be had for the "other" fellow and the next man. . . . An able man's asset is to be sociable, business like, generous to a fault. It is a case of using other men rightly, giving them a square deal and reaping success, or a case of unfairness and plowing on a one-horse farm for a living.—*Canadian Textile Journal.*

A manufacturer attains a position of leadership through the performance and quality of his product. He maintains this position through constant research and development. He keeps in advance of his competition by increasing the service he renders and at the same time preparing for the next step ahead in the ultimate development of his industry.—*Chemical & Metallurgical Engineering.*

The fading of colors, the shrinkage of woolens, damages and shortages are the three great forces for laundry sales resistance. They have cost the laundry industry of this country millions of dollars and will continue to do so until they are corrected. These evils must be blotted from the pages of the laundry industry forever before we can hope to acquire that great volume of business that will enable us to reduce prices and at the same time make reasonable profits.—*A. A. Andrews, in Starchroom Laundry Journal.*

The design of fabrics is the big selling point in the present uncertain markets and it seems to be the general impression in New York that the majority of mills are not paying enough attention to original design and too much attention to copying.—*Fibre and Fabric.*

This is the day of big business. Steel mergers, oil mergers, telephone mergers, railroad mergers, radio combinations, coal combinations, automobile combinations, chain stores, all evidence of the new found economic advantage of mass purchasing, mass selling and mass manufacture. The public is beginning to understand that it owes the quantity, quality and low cost of . . . nearly everything it consumes to large scale enterprise. Public good-will is essential to the success of any enterprise and particularly to large enterprise.—*Robert S. Marx, in Starchroom Laundry Journal.*

NEW TESTING COMPANY

A charter has been issued by the state of North Carolina to the United States Conditioning, Analyzing and Testing Company of Charlotte, organized to test and analyze textile yarns, fabrics, etc., with $100,000 capital stock and with subscribed stock of $5,000. The incorporators are Moses L. Jass and Harry K. Jass of Charlotte and Samuel Jass of Philadelphia.

Papers of the Dye Division, American Chemical Society

Meeting at Swampscott, Mass., September 10 to 14

THE seventy-sixth meeting of the American Chemical Society will convene in the New Ocean House at Swampscott, Mass., next Monday morning, September 10. Details of the general program of this notable meeting have already appeared in these columns. All general and divisional meetings will be held at the New Ocean House, except those of the Rubber and Paint and Varnish Divisions, which will be held at the Hotel Preston and the Deer Cove Inn, respectively. Abstracts of all the papers scheduled for presentation before the Dye Division of the Society follow:

Color Specification—Material, Physical, Psychological

Walter M. Scott, Munsell Color Company, Inc.

The evolution of color understanding is traced through the earlier primitive conceptions of color up to the present modern conceptions. The earliest colorist derived their theories of color from the mixture of colored materials such as pigments or dyestuffs. Later, with the growth of post-Newtonian science, there arose a great interest in regard to those excitable elements which existed in the retina, by whose action color nerve currents were sent to the brain. This led to the formation of a number of theories based on color excitations.

With the development of research on the spectrum, the close relationship of color to light was discovered. This led to the development of color specification on the basis of spectral reflection curves. Finally, with the birth of psychology, scientists began to see that there were complicated processes in the brain which could be observed directly in our minds as sensations. A careful study of color sensations led to the inevitable conclusion that color had three dimensions. The modern specification of color is therefore based on the sensation color solid. (Illustrated with drawings and color charts.)

Applications of Spectrophotometric Ratios

W. C. Holmes, Color Laboratory

The only type of ratio which has found extensive application in spectrophotometry, hitherto, is that of extinction coefficients at the same wave length of different solutions of the same dye in the same solvent. Solutions of unknown dye content are evaluated thereby through comparison with data obtained on solutions of known dye content, in accordance with Beer's law.

A second type of ratio has been found to afford evidence respecting the relative degree of solute aggregation of dyes in different solvents; that is, the ratio of extinction coefficients at the maxima in solutions of equal quantities of dyes in different solvents.

A third type of ratio—that of the extinction coefficients of a solution at two different selected wave lengths—may be employed in determining the relative proportions of two dyes in admixture or the relative proportions of

tautomeric forms of the same dye. Such ratios are of great use in the analysis of dye mixtures, in the study of tautomerism, and in the determination of hydrogen-ion concentrations and of the apparent dissociation constants of indicators. They afford a highly effective means of dye identification and criterion of dye purity.

Recent Spectrophotometric Investigations at the Color and Farm Waste Division

W. C. Holmes

Numerous examples are cited in brief from recent work carried out in the Color and Farm Waste Division to illustrate the variety of scientific investigation in which the application of spectrophotometric ratios (see previous abstract), and of spectrophotometric methods in general, may prove of value.

Absorption Spectra and the Constitution of the Phthaleins—A Study of the Trihydroxy Phenols

C. V. Shapiro and R. C. Gibbs, Cornell University

Measurements on the absorption spectra of phthaleins of pyrogallol, hydroxyhydroquinol, and phloroglucinol in neutral, acid, and alkaline solution are reported. The effect of varying the positions of the hydroxyl groups is very marked, both on the absorption spectra of the individual compounds and on those chemical properties which may be deduced from a comparative study of all the spectra. The relation of the above compounds to the mono- and di-hydroxy derivatives previously studied is pointed out. A point of peculiar interest in the light of the quinoid theory of color production is the fact that gallein, a colored compound, shows a pair of bands which have previously been found to be characteristic only of the colorless, lactoid phthaleins. These bands do not occur in the absorption spectra of related compounds, such as the fluoresceins and sulfonephthaleins, which definitely possess the quinoid structure.

Hydroxyhydroquinolphthalein behaves anomalously when gradually increasing amounts of alkali are added to its neutral solution, for the visual absorption band shifts continuously toward the red and simultaneously changes in character, while its intensity passes through a maximum for intermediate concentrations of alkali. Proceeding hand in hand with these changes in absorption, there is a development and then a fading out of a bright green fluorescence.

Spectrophotometry and Dyeing

Wm. D. Appel and R. T. Mease, Bureau of Standards

In the final analysis the value of a dye depends on the color, or spectral reflection, of the material to which it has been applied. Spectrophotometric reflection measurements give a quantitative record of the color and can be used to advantage in testing dyes, in the study and control of dyeing operations, and in determining the fastness of dyed materials. Illustrative measurements made with relatively inexpensive apparatus are given.

Spectrophotometric Evaluation of Dyestuffs

R. W. French, Army Medical Museum

For greater accuracy and convenience a method for the evaluation of mixtures of dyestuffs is proposed through a combination of the titanous chloride consumption and spectrophotometric findings. To make the method of practical value the determination of specific absorption values is necessary, and to make the values of specific application solvent effect is taken into consideration, or special solvents such as 50 per cent alcohol used. With the spectrophotometric and titanous chloride constants available, it is practicable to use a simplified formula in the evaluation of dye mixtures as the observed values substitute only in the numerators of two fractions.

An Improved Spectrophotometer

R. W. French, Army Medical Museum

An improved spectrophotometer with a direct reading optical photometer and a vertical specimen holder for liquid specimens has been devised. The photometer permits of reading absorption values or percentage of transmission directly as well as affording the usual angular values of rotation for the indirect determination of photometric values through appropriate computation. The instrument also provides means for optical reversal to remove errors due to solvent absorption. The vertical specimen holder is constructed on the general principle of a colorimeter and permits of varying the thickness of layer under examination from 0 to 5.0 cm., and is read with a vernier to an accuracy of 0.05 mm. This aids materially in handling dyes which show marked variations in specific absorption values without the necessity of varying the concentration of dye in solution, as the absorption is directly proportional to the depth of layer under examination.

Further Studies in the Preparation of 2-Amino Anthraquinone from Chlorobenzene and Phthalic Anhydride

P. H. Groggins and H. P. Newton

The authors have continued the work of Max Phillips with a view to developing a detailed procedure which would be applicable not only to 2-amino anthraquinone but also a large number of other similar Friedel-Craft syntheses. The work has involved the preparaton of a comparatively pure product at each stage without resorting to the use of organic solvents or costly recrystallizations.

The chlorobenzoylbenzoic acids are obtained in a pure state with practically theoretical yields. On treatment with ammonia the halogen derivative is converted to 2-amino anthraquinone of 95 to 96 per cent purity. The impurities, characteristic of amidated products, are found to accompany the amino compound. Purification of the autoclave product by recrystallization from sulphuric acid was found to be an economical method of producing a relatively pure 2-amino anthraquinone which is suitable for the preparation of vat dyes.

The Behavior of Pechmann Dyes With Amines. Some Dilactames of Diphenacylfumaric and Diphenacylmaleic Acid, and Their Tinctorial Properties

Marston Taylor Bogert and Irving W. Greenberg

The principal pigments of plants (chlorophyll), of bile (bilirubin), and of blood (hemin), by suitable means may all be broken down into derivatives of maleimide or of pyrrole. Inasmuch as the deeply colored Pechmann dyes show absorption spectra and certain color reactions resembling those of the three natural pigments named, and are likewise derivatives of maleic or fumaric acid, differing only as a lactone differs from its lactame, the production of these lactames was undertaken for the purpose of gaining additional light upon the structure of these natural pigments.

The experiments reported a few years ago by Bogert and Ritter indicate that the Pechmann dyes are probably trans-dilactones of diphenacylfumaric acids. These dilactones react with amines, and amino compounds, to yield the corresponding dilactames, most of which are very deeply colored and many of which are beautifully crystalline. These dilactames dye animal fibers generally violet or purplish shades. The stereo-isomeric dilactame of diphenacylmaleic acid is also described. Wool dyed by production of the Pechmann dye within the fiber is colored a yellow-brown to reddish brown, depending upon the amount of dye used, and this dyeing is very fast to everything except direct sunlight. The reduction of these dilactames to true dipyrroles has not been accomplished as yet, in spite of many trials. Certain new Pechmann dyes are also described. (Lantern.)

Diphenylamine Blue and Nascent Carbon Dioxide

Irving W. Fay, Polytechnic Institute, Brooklyn, N. Y.

By heating an intimate mixture of diphenylamine and oxalic acid to 130°-180° the insoluble diphenylamine blue (in the form of the oxalate) is produced. This work was carried out to determine what part of the oxalic acid furnished the methane carbon as the nucleus of the complex molecule. It must come either from the carbon monoxide or the carbon dioxide. Repeated attempts with the former gave negative results. Repeated experiments in passing carbon dioxide into diphenylamine and conc. sulphuric acid did produce the blue, but in such small quantities and in such a long time in comparison with heating mixed diphenylamine and oxalic acid that the theory of nascent carbon dioxide is proposed to explain the mechanism of the ordinary reaction.

The Rate of Coupling of Diazonium Salts in Buffer Solutions. (Preliminary Paper)

J. B. Conant and W. D. Peterson

The rate of coupling of diazonium salts and phenols has been measured by a colorimeter method accurate to about 10%. Buffer solutions of definite acidity (pH value) and definite salt concentration were employed. A number of approximate determinations of the coupling range of a variety of diazonium salts and phenols led to the choice of the following combinations for the more exact study: (1) diaz. o. anisidine plus N. and W. salt; (2) diaz. o. anisidine plus R salt; (3) diaz. sulphanilic acid plus p. phenolsulphonic acid; (4) diaz. sulphanilic acid plus R salt; (5) diaz. sulphanilic acid plus N. and W. salt. The rate of the reactions approximated closely to that calculated by the bimolecular formula over a 100-fold change of concentration of the reactants, and was a function of the pH value of the buffer if the salt concentration was constant. Change of one pH unit changes the rate tenfold. (Lantern.)

The Mechanism of Azine Formation

M. L. Crossley

A preliminary discussion of the mechanism of the reactions involved in the formation of azines. Based on recent work, it appears that diphenylamine is an intermediary step in azine formation. New reactions involving sulphonic acid salts of amines as initial material throw additional light on the mechanism of the azine reaction.

pH Control in the Textile Industry

Chas. E. Mullin, Clemson College

Just as in most other industries pH control finds innumerable applications in many of the wet processes of the textile industry. As the animal fibers are amphoteric and more liable to injury than the vegetable fibers, it is particularly valuable in the control of most wet processes on silk and wool, from the boiling-off or scouring of the raw material, to the dyeing and finishing of the goods. However, its usefulness is certainly not limited to the animal fibers and pH control will find many applications in cotton manufacture, from kier boiling to scrooping and finishing, including the application of the vat dyes; sizing preparation, application, and removal; as well as dyestuff manufacture, etc.

A Preliminary Paper on the Incorporation of Oil-Soluble Solvents Into Soap, and Their Subsequent Action on the Scouring of Artificially Soiled Fabric

Robert W. Jaeger, Jr., Armour & Co.

Results contrary to a large amount of material found in the literature have been found on the comparative detergent efficiency of scouring baths, containing in addition to the usual soap and alkali or scouring assistants an amount of incorporated hydrocarbons. Investigations were made using a modification of the American Oil Chemists' Society Detergent Method, on flannel material soiled in a CCl_4 solution of seresin, lanolin, cylinder oil, and roofing tar.

Solvents examined included hexaline, tetraline and pine oil. Experiments were made with three types of soap: half saponified soap (showing 15% free fatty acid), fully saponified or neutral soap, and soaps containing an excess of Na_2CO_3. Quantitative results showing amount of

soil present on the fabric, and relative efficiency of various soap solvent systems for removal of same are tabulated in detail.

Dyeing of Rayon and the Capillarity Test

Allan A. Claflin

In dyeing rayon skeins, every now and then one skein will be found much brighter than another, or if the rayon is woven in the piece, e. g., cotton warp and rayon filling, there will be found light stripes across the piece. Microscopic studies show that this variation is due to the offending thread not being evenly cylindrical. Unfortunately it is not practicable to examine microscopically all rayon threads. Therefore unevenness constantly shows up, although due to perfection in manufacture it is not as serious as formerly. Selection of dyestuffs has helped a great deal. C. M. Whittaker, well-known British dyestuff authority, devised a test for suitability of dyestuffs, based on their capillary rise in strips of filter paper. Dyes that rise highest are best to cover up unevenness. Addition of usual assistants accentuates unevenness.

Experiments were undertaken first by the Whittaker method and then checked by dyeing rayon, first, to see if by capillary method any additions or assistants would increase rise, also relation of rise to temperature, time, concentration, etc.; second, relation of capillary results to rayon dyeing.

Conclusion: Capillary rise and even dyeing is favored by using as high pH as permissible. Using assistants which decrease surface tension of water does not increase capillary rise. Phenomena apparently are of solubility; glycerine and diethylene glycol give favorable results. More concentrated dye bath lessens difference between dyestuffs. Rayon dyeing confirms laboratory results by Whittaker method.

Methods of Boiling Off Silk

W. W. Bray, J. B. Crowe and S. Mecker

Silk piece goods are usually degummed in one soap bath through which pass several strips. Accumulations of acid soap, color compounds and oil with successive strips increase respectively degumming time, color of stripped silk, and likelihood of oil spots. A two-bath method is recommended. Pieces enter Box A, containing slightly exhausted soap from completing a previous strip. Here the gum, color, and oil are largely removed. The boil-off is completed in fresh soap (Box B). Four strips pass successively through both boxes. A, completely exhausted, is emptied and refilled with fresh soap. Raw silk now passes first through B, then A. For most silks one hour in each box with 20 per cent soap (silk basis) overall is sufficient. Since each strip is finished in fresh soap, gum removal and color of silk are uniform from first strip to last. Oil spots are eliminated. A 10 per cent reduction in soap consumption is possible.

A Machine for Laboratory Washing Tests

Wm. D. Appel, Wm. C. Smith and Hugh Christison

Co-operative work by the American Association of Textile Chemists and Colorists and the Bureau of Standards has resulted in a practical machine for testing the fastness to washing of dyed textiles. With it one man may test up to twenty samples simultaneously and in a brief run obtain results similar to those obtained in commercial laundry practice. It is also suitable for testing detergents, for dry-cleaning tests, and for laboratory dyeing. The machine is described and general specifications for it and for a standard washing procedure are given. The machine is being manufactured and may be obtained through the Association.

Early Documentary References on the Use of Dyestuffs in America

C. A. Browne

A brief history of the use of colors by the Puritans and their successors in New England, including dyes imported from Europe and those obtained from the Indians. The story concludes with the introduction of fuchsine, the first coal-tar dye used to any considerable extent in the United States.

PRACTICAL HINTS ON THE PRODUCTION OF BRIGHT COLORS

(*Continued from page 564*)

dyestuffs employed, the width of the stripes themselves, and the difference between one series and the other.

In special goods, one of the contrasting colors can be placed in the lines running across the weft, and the other in the lines running down the length of the cloth. As contrasting colors of great effect the following can be employed: yellow and blue, yellow and green, orange and red, pink and blue, green and violet, blue and velvet, red and blue, red and green, black and gray, black and yellow, brown and yellow, brown and red, red and yellow, etc.

(*To be continued*)

NORTHERN LIGHT LAMP INSTALLED BY TEXTILE SCHOOL

Two units of precision apparatus for producing northern light or sky light have been installed by the dye laboratory of the Textile School of North Carolina College. These lamps are the result of much research and were developed in the laboratories of the National Lamp Works. It is believed that they will be of value to the students in color matching studies on yarns or fabrics.

This school also recently installed a Saentis enlarging camera for enlarging textile designs accurately. Its chief use will be in connection with the making of jacquard designs.

FAST COLOR TEST AND LABEL DEVELOPED BY COTTON FINISHERS

Laboratory Tests to Be Applied Under License to Members

TO help clarify the confusion arising out of meaningless fastness claims and guarantees made in connection with the retailing of cotton fabrics, the National Association of Finishers of Cotton Fabrics has come out with a proposal whereby its members and others handling dyed goods will be protected and consumers satisfied. A standard procedure has been formulated by the association by means of which color fastness can be determined by laboratory tests carried out by the Pease Laboratories of New York City. A label attesting to the fabric's fastness has been devised for use on these tested materials, this label designating such goods as "Nafal Tested Fast Colors."

The association's statement follows:

"If the consumer wants colors in fact fast, and they are so presented and guaranteed, prices should be charged which will warrant the use of dyes and processes which will insure results as represented.

"In order to compose differences regarding fast colors, and co-operate with all who are interested in protecting the public against misleading statements, the finishers have made a thorough study of this question during the last year.

"The National Association of Finishers of Cotton Fabrics has now completed arrangements for the testing of all goods as regards the fastness of colors to both light and washing for all practical purposes. Samples of each lot of goods will be sent to Pease Laboratories, Inc., of New York City, for a thorough testing to light and washing, made according to approved standards and requirements. If the goods withstand these tests, they then, but not otherwise, may bear the association label showing that such tests have been made. The use of this label is optional on the part of the owner of the goods. The finishers' association merely offers this method of procedure to see to it that only those goods are represented as fast which are entitled to be classified for all reasonable and practical purposes.

"The laboratories are impartial and independent. All precautions have been taken to guarantee true and scientific tests of samples of each lot of goods. Such a label will stand for honesty and fair dealing. It will protect both merchant and finisher, and should be heralded a step in the right direction and do much to correct trouble emanating from misstatements regarding fast colors.

"The association's copyrighted 'Nafal Tested Fast Color' label is supplied to member finishers under a license agreement to use such ticket only as prescribed and not otherwise. There is nothing on this label to identify any particular finisher or converter. There is nothing to prevent a converter or finisher from using his own special brands or names in addition to this label."

License Agreement

The form of the license, referred to above, follows:

License
National Association of Finishers
of Cotton Fabrics
320 Broadway, New York

This certifies that ..... of .....(City) ..... (State) hereinafter called "Licensee," is a member of the National Association of Finishers of Cotton Fabrics and is licensed to use this Association's Tested Fast Color Label on such part of the goods processed by Licensee as Licensee will warrant shall be subject to the following conditions:

(1) That a sample of each shade of each lot of goods and each dyeing of each shade, if the shade be dyed at different times, shall have been first submitted to and tested and approved by the Pease Laboratories, Inc., of New York City, according to standards regarding fastness of colors adopted by this Association.

(2) That said Label shall be used only to identify such goods as have been first so tested and approved, but not otherwise. In each instance, each Label shall bear the Pease Laboratories', Inc., "Test Number" assigned by it for the particular test.

(3) That if at any time the Licensee should cease to be a member of this Association, this license to so use this Label shall cease.

(4) That the charges for making such tests will be paid by the Licensee for all samples so tested for the Licensee, at the rates agreed upon by this Association and said Pease Laboratories, Inc.

(5) That if said Label be used in any manner which would conflict with the provisions of this License, as determined solely by a majority of the Executive Committee of this Association, this License to use said Label shall forthwith be automatically revoked.

(6) That the Licensee agrees that the Association may, with the approval of its Executive Committee, cause said Label to be copyrighted and/or registered in such manner as may be legally permitted on behalf of and for the benefit of the Association and its members who elect to use the same, and the Licensee agrees to render all possible assistance to the Association and its members to whom licenses, similar to this one, have been granted, in protecting this Label and preventing its use in any other manner than as herein prescribed.

(7) This License may be terminated at any time by the Association or the Licensee upon thirty days' written notice to the Association or the Licensee as the case may be. In the event of such termination of this License any dues or assessments paid or required to be paid to the Association as provided by its Constitution and By-Laws shall not be abrogated or affected, nor shall the Licensee be released from the payment of any obligations incurred, up to the

time of such termination, for testing samples or otherwise in pursuance of this License.

(8) This License is subject to the right of the Association to make changes or additions herein which may seem proper to the Association, upon thirty days' written notice to the Licensee, and if so altered at any time hereafter, such amended License shall remain and continue in full force and effect.

In Witness Whereof, the Association and Licensee have caused this License to be signed this .....day of ....., 192...

NATIONAL ASSOCIATION OF FINISHERS OF COTTON FABRICS.

Attest: .....
Secretary

By.....
President.

.....
(*Licensee*)

Attest: .....
Secretary

By.....
President.

DUST AS A FUEL POSSIBILITY

By W. E. SCHAPHORST, M. E.

THE Department of Agriculture recently caused considerable speculation and comment by operating an automobile engine on grain dust. Although it operated very feebly the event is heralded by some papers as "epoch making." One paper asks, in a humorous vein, I presume: "Can any one hope that some day a few minutes use of the vacuum cleaner will furnish the fuel needed to make the week-end trip in the flivver?"

Probably in a few isolated instances it will some day be possible to economically utilize dust as an explosive fuel, but I have my grave doubts.

It is true that dust explodes and that with each explosion force is exerted and some power is available. The force is considerable, too, in a few cases, as with flour dust, coal dust, grain dust, etc., but nevertheless the natural supply of dust, even in the "dusty industries," is very small, and hardly sufficient for serious power consideration. The only possibility of dust utilization, as I see it, would require the grinding of grain, starch, sugar, etc., into very small dust particles and then utilizing it in the same way that Diesel tried to use coal dust in his engine.

It is commonly believed that a pound of gun-powder or a pound of nitro-glycerine, or TNT, contains more energy than a pound of coal, but not so. A pound of coal contains more energy than a pound of any of the high explosives.

The same is true of grain dust: A pound of grain dust contains less energy than a pound of coal or a pound of oil. Therefore by using dust we are not getting something for nothing.

Hamilton Piece Dye Works of Paterson, N. J., has been granted a permit for a brick dyehouse addition to cost $4,000.

TESTING PROCEDURE FOR DESTRUCTIVE AGENTS ON DETERIORATED COTTON TEXTILES

DETERIORATED textile fabrics and yarns frequently present a very difficult problem to the textile chemist. This is especially so in the case of laundry materials where often accumulative deterioration occurs and the destructive agent is almost entirely removed by the laundry process. The problem then is the detection, identification, and estimation of chemicals of microscopic size.

The technical literature discloses that general methods are available for the most likely destructive agents. Other methods dealing more specifically with textiles are to be found in technical and trade publications in the textile field.

In connection with a study of deteriorated textiles it was necessary to formulate a procedure for estimating the maximum number of possible destructive agents with a minimum of samples available.

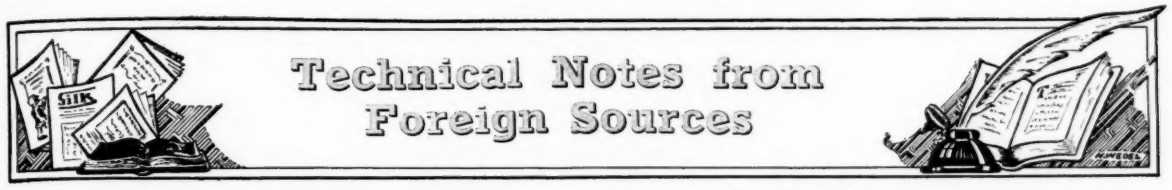
This procedure covers the analysis of a deteriorated cotton textile fabric for total silica, iron, aluminum, sulphates, total acidity, oxalates, soluble sulphates, soluble chlorides and combined chlorides.—*Technical News Bulletin of Bureau of Standards.*

COLOR MEASUREMENT IN DYESTUFFS

(*From The Chemical Age, British*)

IN America, one research association alone has 9,000 specimens, involving 550 different dyes, under observation for fastness to light, while in this country the woollen, silk, and cotton industries are also carrying out hundreds of tests. Germany also has elaborate researches on the subject in progress.

The advantage of being able to correlate all the results obtained in terms of an accepted standard is obvious. Much certainly remains to be done before that stage can be attained, but it can be said that the necessary foundation has been laid, the various factors involved have been investigated, and a fairly accurate estimation made of their relative importance. The purely scientific investigator can, therefore, reasonably expect the technologist to make use of the instruments already devised. For popular use it will always be the custom to provide a color with an attractive name, and we shall always in ordinary conversation compare colors with flowers and other productions of nature. There is, however, no more reason why when dealing with the purely technical and commercial aspects of an object we should be any more vague about its color than we are about its length or weight; indeed, one might reasonably argue that an increased knowledge of color and its composition would increase rather than decrease our purely aesthetic appreciation of it.



Non-fastness of Dyestuffs to Ironing

R. Haller, J. Hackel M. Frankfort, Kolloid-Zeiitsch. 44, 83 (1928); *see also Chem. Abstr.* 168, 22.—The theory has been previously advanced that dyestuffs not fast to ironing consist of two phases possessing different colors, the equilibrium between which shifts with change in temperature. This theory is claimed to have been confirmed by applying the Fuerth method of observing the change in color of dyed semi-electrodes when the polarity is changed (cf. Chem. Abstr. 3517, 21). The dyestuffs examined were Congo Rubin, Diamine Blue 3R, Bordeaux Extra, Benzazurine G and 5G, Benzo Brown RC, Brilliant Benzo Violet 2R and Brilliant Benzo Fast Violet 2RL.

Recent Development of Organic Dyestuffs for Lake Colors

A. Wahl, L'Ind. Chim. et Rev. Gen. des Mat. Col. (*I. C.* 177), 17, 15 (1928).—An interesting article, though not of direct bearing upon the dyeing industry. The author points out that the properties which make a substance valuable as a dyestuff are either used as the basis detrimental to a pigment which is to be used as the basis for a lake for paints. The properties of an ideal pigment for lakes, for example, are total insolubility in water, alcohol, oils, or any liquid which may appear in the medium or varnish or diluent of these in the finished paint; high covering power; resistance to heat up to 140 to 150° C., and permanence to light in the solid form. Lithol Red, discovered by Julius in 1889, was the first dyestuff really suitable as a pigment. It is the product obtained by coupling 2-naphthylamine-1-sulphonic acid to beta-naphthal. Strangely enough, it has been found that the acid group, either sulphonic or carboxyl, if it occurs in the nucleus of the second component (the beta-naphthol ring) instead of the first component, loses its power of conferring pigmental qualities upon the product. A large number of possible combinations, many of very great value, have been prepared and studied, and involve not only the familiar azo-coupling reaction, but, for example, in the basic series, combination with such unusual reagents as phosphomolybdic and phosphotungstic acids. The vat dyestuffs of the anthraquinone and benzanthrone series have also been drawn into contribution.

Soaps in Acid, Hard-Water or Salt-Water Baths

English Patent No. 253,105; *I. G. Farben-Ind. A. G.* (*B. A. S. F.*).—Troubles from precipitation when using soaps in baths containing free acids, calcium or magnesium salts, etc., may be avoided by adding aromatic or hydroaromatic sulphonic acids of a high wetting power, such as naphthalene-sulphonic acids, containing one or more isopropyl or butyl groups. Sulphite cellulose waste liquor may be used also with the same effect. By this means acid dyestuffs may be applied in the presence of soaps, Turkey Red oil, etc., and wool may be scoured with soap even in an acid bath.

In a later (English) patent, No. 280,110, it is pointed out that the aromatic or hydroaromatic sulphonic acids, or their salts, may be mixed with the soap before use instead of during the process. Other suitable desired compounds, such as benzine, borax, sulphite cellulose waste liquor, etc., may be mixed with the compounds. It is claimed that with the sodium salt of butyl-naphthalene sulphonic acid and sulphite cellulose waste liquor goods may be fulled while containing acid, even in baths o fhard water, without any fatty acids being precipitated.

Selection of Direct Cotton Dyes for Viscose

Kunst-Scide 161, 10 (1928).—Courtaulds, Ltd., communicate a new and simple test, which enables a more selective comparison to be made between different cotton dyestuffs, with a view to their suitability for viscose, than has been possible with the suction or capillary tests used and recommended recently. With the latter test, for example, Sky Blue FF and Benzo Fast Blue 4GL give suction numbers of 9 and 8 respectively, but experience on the large scale has shown that, in spite of the only slight difference in the suction numbers, the latter dyestuff has given much poorer results than expected. The new test is called the "temperature range test," and depends upon the fact that a particular dyestuff possesses a maximum affinity for the fiber, which is at a maximum at a certain definite temperature (within, of course, a few degrees limit), and that this optimum temperature is by no means the same for even closely-related dyestuffs. The method of carrying out this test is as follows:

(a) Dye liquor sufficient for eight tests is made up of the dyestuff under examination, and is divided into eight parts, equal volumes, each bath thus containing the same amount of dyestuff and assistants. The liquor is made up by boiling up all the dyestuff, soap, and Glauber salt in one-half the liquor, then adding the rest as cold or warm or hot water. The ratio of liquor to viscose is 40 to 1 throughout. Sufficient liquor was, in the tests, made up for nine baths, in order to insure having enough for the eight baths. The percentage of the dyestuffs tested was based on a ½% Sky Blue FF shade, so as to give approximately the same depth of shade at 90° C. The assistants used were 2% soap and 10% Glauber salt.

(b) Eight small skeins of viscose are wound off from the same commercial skein to assure equal dyeing affinity.

(c) These skeins are dyed for one-half hour in the eight

dye baths at the following temperatures: 20°, 30° 40°, 50°, 60°, 70°, 80°, 90° (baths preheated to the requisite temperature). This might be of some importance in some cases, but the paper is not clear on this point.—Tr.

As to results already obtained by means of this test, it may be noted that almost every possible variation exists. Chrysophenine G and Icyl Orange G show maximum affinity at 20°, which slowly decreases with rising temperatures. Chlorantine Fast Green BL and Benzo Fast Brown GL show minimum affinity at 20°, but this increases to a maximum at 90°. Pyrazol Orange G and Brilliant Benzo Green B show maximum affinity at 50° to 60°, and this maximum affinity decreases at lower and higher temperatures. In general, those dyestuffs which show maximum affinity at 20° give the most even results on large-scale work, while those whose maximum affinity lies around 90° give the most uneven dyeings. This fact enables one to select the most suitable dyestuffs for self-shade dyeings, and moreover is of even greater value in working out the selection of components for compound shade baths. Ideally, such dyestuffs should be chosen which possess maximum affinity at 20°, or at least whose maximum affinities lie at the same, and low, temperature. This unfortunately cannot be completely done at present, since a full range of direct cotton dyestuffs of these characteristics is not yet available; but this problem is being investigated by dyestuff manufacturers.

A good example of the practical bearings of the above may be quoted: "Even dyeing browns may be built up from combinations of Icyl Orange G, Diazo Brilliant Orange GR (used as a direct dyestuff), and Direct Fast Black B, because all these dyestuffs show maximum affinity at 20°; if however, Chlorazol Fast Orange AG is substituted for Icyl Orange G, an uneven dyeing combination is produced, because Chlorazol Fast Orange AG shows minimum affinity at 20°, and maximum affinity at 90°. Such a combination should not be used; and if the fastness of shade demanded compels the use of Chlorazol Fast Orange AG, it should be combined with Benzo Fast Light Scarlet 4BL and Benzo Fast Gray BL, because they also show maximum affinity at 90°.

The fact that dyestuffs which possess maximum affinity at the lowest temperature are the most level dyeing does not imply that they have to be dyed at that temperature, as viscose should always be dyed at as high a temperature as conditions permit. Dyestuffs such as Icyl Orange G, which dye viscose perfectly even at 90°, give uneven dyeings at 20°.

(Note.—All temperatures in the above are in Centigrade values.)

Dyeing of Acetate Silk

Dr. P. Rabe and I. G. Farbenindustrie A. G., German Patent No. 439,000.—It is claimed that in dyeing acetate silk with basic dyestuffs the addition of pyridine or its homologues to the dye bath gives deep and more fast dyeings than without that addition, one of the dyeings being faster to light than those of the same dyestuff on tannin-mordanted cotton. In the example given, the dye bath contains 9.1 g. of Diamond Fuchsin dissolved in 100 c.c. of water. One c.c. of pyridine is added to the solution, and the goods entered at 60 deg. Cent. After dyeing the goods are rinsed, soured with dilute acetic or formic acid and dried.

It is considered that such substances as pyridine act not only as assistants in solution in the dye bath, but help the actual absorption of the dye itself by the fiber.

Printing Upon Acetate Silk Mixed Weaves

Dr. Erich Heim, Zeitschr. fuer Farbenindustrie 64, 20 (1928).—A general paper, containing perhaps little if anything new, but a good summary of the possibilities of the subject.

Present Position of the Dyeing of Artificial Silks

Dr. H. H. Hodgson, Zeitschr. fuer Farbenindustrie 66, 20 (1928).—A paper of general nature, by way of summary of the subject. As is natural, most attention is given to cellulose acetates, and this section of the paper is a very valuable, concise record of the present status of the dyeing of this particular artificial fiber.

Uneven Dyeing on Artificial Silks

Dr. H. Hoz, Zeitschr. fuer Farbenindustrie 68, 20 (1928).—A general paper, a summary or review of the subject of facts unfortunately well known to dyers who work with that material. Dr. H. gives two lists of (German) dyestuffs, the members of the first giving level dyeings on a specimen of uneven dyeing artificial silk, the members of the second list giving what might be called passable results. It seems hardly worth while to quote these dyestuffs, since American artificial silk dyers have mostly worked out similar lists for themselves of dyestuffs of American manufacture.

New 2-3-Hydroxynaphthoic Anilides

English Patent No. 281,795.—*British Dyestuffs Corporation, Ltd., J. B. Payman and H. Wignall.*—New "Naphthol AS" products, obtained by heating 2-3-hydroxnaphthoic acid with aromatic sulphonamides, such as aniline m-sulphonamide or anilide, in the presence of phosphorus trichloride and a diluting agent, such as benzene, toluene, etc.

Yellow Mono-Azo Dyestuffs

English Patent No. 276,353, *I. G. Farbenindustrie A.-G.*—By coupling the diazo-salt of 2-5-6-trichlor-3-amino-toluene-4-sulphonic acid to 1-p-sulpho- (or sulpho-chlor-) phenyl-3-methyl-5-pyrazolone, or the corresponding 3-carboxylio acid or esters. The products are acid dyestuffs and are claimed as faster to light than Fast Light Yellow 3G or Flavazine 3GL.

DYE IMPORTS RECORD SLIGHT INCREASE

FOREIGN dyes imported through New York and other ports during the month of July were slightly higher in quantity and value than for the preceding month, with a total of 424,613 pounds and an invoice value of $334,849. Imports by ports were not shown in the Government report for this month. Detailed figures follow:

	1928		1927	
	Pounds	Invoice Value	Pounds	Invoice Value
January	415,156	$327,148	196,620	$186,387
February	478,407	391,351	312,277	262,364
March	378,191	316,183	404,714	352,414
April	633,815	505,152	402,783	323,732
May	382,233	295,969	349,476	265,752
June	411,662	309,607	318,450	253,054
July	424,613	334,849	263,162	214,853
Total 7 months	3,124,077	2,480,259	2,247,482	1,858,556

Per cent of Dyes by Country of Shipment

	July, 1928	July, 1927	Jan.-July, 1928	Jan.-July, 1927
Germany	70.6	63.5	65.08	57.05
Switzerland	22.6	22.0	23.79	25.48
France	1.0	2.0	1.615	3.21
England	2.2	2.0	2.255	4.23
Belgium	1.1	5.5	2.70	5.44
Canada	1.1	4.0	2.13	2.71
Italy	0.5	1.0	1.13	1.77
Netherlands	0.9	..	0.70	0.11

Leading Dyes, by Quantity, Imported During July

	Pounds
Vat Brown G (single strength)	17,800
Rhodamine 6GH (single strength)	17,210
Alizarine Red VI paste	15,389
Vat Golden Yellow GK (single strength)	14,204
Erioglaucine AP	11,464

Remaining in Bonded Customs Warehouse

	Dyes and Colors Pounds	Intermediates Pounds
January 31, 1928	609,573	818,695
February 29, 1928	636,566	1,291,636
March 31, 1928	716,032	1,264,965
April 30, 1928	740,239	506,337
May 31, 1928	778,670	1,873,016

United Indigo and Chemical Company of Great Britain recently declared a final dividend of 8¾ per cent on the company's ordinary and preferred shares, the same as last year. The United Turkey Red Company of Glasgow has declared an interim dividend of 3 per cent.

GREENE RETIRES FROM PACIFIC MILLS

After serving as treasurer of the Pacific Mills for twenty-one years Edward Farnham Greene resigned last week to become the head of a new organization. At a meeting of the directing board of the Pacific Mills held just prior to Mr. Greene's retirement Alfred E. Colby was appointed treasurer and a member of the board to succeed Mr. Greene. Mr. Colby has been assistant treasurer since 1919.

As treasurer of Pacific Mills, E. F. Greene was its chief executive and under the management of himself and his associates the business of the company grew to annual net sales of $44,000,000 in 1927. Assets increased from $8,000,000 in 1908 to $60,000,000 in 1928. The company has added plants at Dover, N. H., and Columbia and Lyman, S. C.

Mr. Greene, who was born in Hills Grove, R. I., in 1879, comes of a New England family that has been associated with the textile industry for more than 100 years. Upon his graduation from Brown University in 1901 he became president of Lockwood, Greene & Co., engineers, and, until 1926, held that position during the period of the company's development into one of the largest engineering corporations in the United States.

Mr. Greene was formerly treasurer of the Lawton Mills Corporation, and treasurer of the Dwight Manufacturing Co.

A GOVERNMENT RESEARCH JOURNAL

A monthly journal of scientific research and experimentation is now being published by the Bureau of Standards of the Department of Commerce. It is entitled the "Bureau of Standards Journal of Research" and will contain full reports of the bureau's experimental investigations in various branches of industrial research, as well as critical reviews in the fields of science and technology. These will, it is stated, be comparable in importance and interest to the numerous bureau papers already issued.

The union of pure and applied science in one journal will, it is believed, help to bridge the gap between the two fields and in that way shorten the lay between discovery and its application. Each volume will be indexed and a cumulative consolidated index will be included in the bureau's list of publications. The subscription rates to the new journal are $2.75 in the United States, Canada, Mexico or Cuba and $3.50 per year for other countries. Remittances should be sent to the Superintendent of Documents, Government Printing Office.

A new dyehouse of frame, brick, steel and concrete construction will be erected by H. H. Brown & Sons, dyers and bleachers of Paterson, N. J. This will adjoin their present plant on Fourth Avenue, and will cost $15,000.

ACTIVITIES OF THE I. G.

An interesting review of the manufacturing activities of the I. G. Farbenindustrie in the widely diverse fields of chemical production under its control is given in the Berlin Letter of Industrial & Engineering Chemistry.

At the regular general meeting of the I. G. Farbenindustrie, Geheimrat Bosch announced that since the fall of 1927 increasing quantities of benzine had been put on the market and disposed of without difficulty. By the end of the present year the anticipated production of 100,000 tons of benzine will have been realized, and this output can be doubled in 1929. An expansion of the plants will not be necessary, as the capacity has been increased by improvements in the process. The hydrogenation of coal is also to be conducted on an enlarged scale. Geheimrat Bosch further explained that obviously profits are essential since eventually the tariff will be removed. But this requires time—the production of nitrogen required fifteen years to reach its present position. There is hope, however, of profitable operation by the end of this year. Coal liquefaction pays only on quite a large scale. In the field of rubber prduoction they are making additional experiments and have achieved progress in the laboratory, but production cannot yet be undertaken. In this connection, Geheimrat Bosch emphasized that the field of rubber synthesis is far greater and more important than that of artificial benzine. At present 11,000 to 12,000 kg. of viscose and cuprous artificial silk are being turned out daily. After completion of their plants they hope to attain an output of 22,000 kg.

BRITISH DYE PRODUCTION OUTLINED

A substantial increase in the consumption of dyestuffs in Great Britain is recorded in a survey of production and imports of dye products recently issued by the Chemical Division of the Department of Commerce. This survey was made by Trade Commissioner Homer S. Fox of London and contains data on Britain's dye imports from various countries and statistics on prices.

One of the outstanding points made by the Chairman of the Color Users' Association at its annual meeting was a strong plea for more complete statistics of the production and consumption of dyestuffs in Great Britain, such as those published each year in the United States Tariff Commission's "Census of Dyes and Other Synthetic Organic Chemicals." Another important feature of the Chairman's remarks was the importance attributed by him to the necessity for greater amalgamation among British dyestuffs makers, similar to that which had taken place in the heavy chemical industries through the formation of Imperial Chemical Industries (Ltd.). While the leading British maker of dyestuffs is now included in the I. C. I., there are still several important companies outside of this amalgamation, and it is apparently the opinion of the leading color users that, in order to develop most efficiently the dyestuffs industry of the country, a further amalgamation of these producers, or at least a much closer working arrangement, is of vital importance.

The rate for "Position Wanted" advertisements in this column is 2 cents a word—with a minimum of 50 cents per insertion. For all other types of advertisements—*i. e.*, help wanted, machinery or supplies for sale—the rate is $5.00 per column inch or less per insertion.

DYESTUFF SALESMAN

Experienced dyestuff salesman, well known by entire textile, leather, paper industries, etc., in territory covered by him for many years, offers his services to first-class manufacturing concern. A-1 references given. Address: Classified Box 466, American Dyestuff Reporter.

TEXTILE CHEMIST

Textile chemist and dyer wants steady position. Eighteen years' experience. Thoroughly competent in all lines of bleachery work, including art silk mixtures and vat colors. Can supervise development work or handle production. Address: Classified Box 475, American Dyestuff Reporter.

HOSIERY DYER—CHEMIST

Thoroughly experienced hosiery dyer and chemist, with many years' experence on high-grade full-fashioned and seamless work, is open for position. Address: Classified Box 476, American Dyestuff Reporter.

CHEMIST

Young man, technical school training, laboratory and color shop experience, desires position in laboratory of dyestuff company or print works. Capable. Best references. Address: Classified Box 477, American Dyestuff Reporter.

TEXTILE CHEMIST

Textile Chemist desires a position in a laboratory. Textile school graduate with experience. Position in print works preferred. Address: Classified Box 478, American Dyestuff Reporter.

DYESTUFF SALESMAN

Aniline dye salesman wanted. One with experience who is acquainted with the Philadelphia territory. State past experience and salary desired. Address: Classified Box 479, American Dyestuff Reporter.

CHEMIST-SALESMAN

A graduate textile chemist with both plant and selling experience seeks a position as salesman. Age 25 and single. Address: Classified Box 480, American Dyestuff Reporter.